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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

NOVEMBER 29.

Sheffield Metallurgical Association:—Ordinary meeting. "The Constitution and Properties of Silica and Fireclay Products in Relation to Open-Hearth Steel Practice." Paper by A. T. Green.

Institute of Metals (Birmingham Local Section):—Ordinary meeting. "Corrosion," Paper by Dr. G. D. Bengough, M.A. Joint programme arranged by the Birmingham Metallurgical Society, the Staffordshire Iron and Steel Institute, and the Birmingham Local Section of the Institute of Metals.

DECEMBER 3.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. "Foundry Practice in United States, America." Paper by E. Longden.

DECEMBER 7-9.

Institution of Chemical Engineers:—Conference in London. President, Sir Alexander Gibb, G.B.E. C.B.

DECEMBER 14-15.

Institute of Chemistry of Great Britain and Ireland:—Jubilee celebration in London.

Custom of the Trade.

The correspondence now running through our columns on this subject is of noteworthy importance. Two questions were raised in the original letter. Primarily, a foundry owner continued to make castings from a worn-out pattern and desired to establish whether the onus was on him or his customer for the replacement of the defective castings so caused. We insist that it is the duty of the foundry owner to cease manufacture and inform the customer the moment a pattern becomes so worn as to jeopardise the utility of the resulting casting. The second question was one of infinitely greater importance, relating, as it did, to the charging back to the foundry of machining costs put upon castings found to be defective. In this case exactly the same argument should apply. The moment any casting is found to be defective the batch should be taken out of production and the foundry notified. This gives the founder the option of replacing them or, perhaps, taking a chance on the balance machining up correctly. We believe it is desirable that an authoritative statement should be made by the recognised foundry employers' association, and their decision should be printed as a "Condition of Sale" on the quotation forms of all affiliated firms. If the majority of high-class firms do this, there would be no question of custom of the trade; it would be a definite contractual arrangement. If buyers cared to buy from firms not so covered, they would then be in a position to assume that machining costs on defective castings are recoverable from the suppliers, and would expect to see a corresponding increase in the sales price.

A private letter from an important foundry owner confesses that he has paid away hundreds of pounds under this heading in the course of recent years, which obviously weakens any legal argument based on "custom of the trade" put forward as a saving clause. Thus we strongly advise all founders to unify their "Conditions of Sale" clauses, and create a fund, if necessary, for their legal upholding.

Machining costs are a type of consequential damage from which founders, above all classes of industrialists, must be adequately protected. Remember that one casting sold at £600 once cost a foundry several thousands of pounds, which damages, to our mind, were purely of a consequential character.

Trade Fluctuations.

Information has recently reached this country concerning the German Institute for the Study of Trade Fluctuation, which throws further interesting light upon the almost wholesale adoption there of any measures which seem to promise assistance in the development and stabilisation of industry. The Institute appears to be a State body, since it is controlled by an officer of the Federal Statistical Bureau. Its work is easier than would be that of a similar body over here, for German industrial statistics are more complete than our own, while a sales tax on wholesale and retail turnovers provides an accurate index to the home trade.

Trade forecasting has been much discussed in this country recently, and it will be generally admitted that the business community would stand to benefit considerably by some reliable indication of the state of trade, whether it is improving or declining, whether a promised boom is a mere flash in the pan or the beginning of a long-period change. Trade forecasting became immensely popular in the United States after the serious industrial crisis of a few years ago, and it has been widely studied there. Like so many developments of its kind, its indirect results have proved more valuable than its direct results. Whether forecasting has been useful in America or not, the problem is clearly at its simplest for a more or less self-contained country with a large, uniform home market, for, with respect to basic industries, the United States are virtually self-sufficing. British trade covers the world, and is inevitably much more difficult to forecast.

Many people are not convinced that there is any sort of regularity in the so-called business cycle. It may be admitted that business fluctuates, now advancing to a boom, now diminishing to a depression, but each rise and fall may represent the summation of a series of world-wide economic movements, prophecy with regard to which may well baffle the most expert and omniscient forecaster. The results of the coal dispute, for example, affected business, both while it lasted and since, more than many more normal economic disturbances, but its length and effects could not possibly have been foretold. A very small variation on the anticipated curve might easily mean bankruptcy for a big section of an industry. These qualifications should not, however, be taken as any disparagement to the value of the study of economic tendencies.

The most obvious and immediate direction in which a manufacturer might make use of forecasting is in the study of the selling market and of the influences which affect it. If he is selling heavy plant the conditions governing possible sales will be entirely different from those governing the sales of small goods of the domestic or luxury type which go straight to the public, and which are on the whole far sooner affected by fashion, seasonal, climatic and other changes.

In the latter case, extra demand is still usually met by running overtime, etc., while efforts are made to fill the gap when a slump occurs by an extension of advertising and publicity, by special sales efforts and reduced prices.

In the former case, on the other hand, the problem is much simpler. A wet summer or a change of fashion does not usually affect the market for heavy goods, such as we in the foundry are concerned with, and it is in this field, therefore, that the most successful business forecasting has been done in this country. Certainly it does appear to offer very real advantages in such cases, and its possibilities should be most carefully explored.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Nomenclature—The Spun-Sorbitic Process.

To the Editor of The Foundry Trade Journal.

Sir,—I should like to have the opportunity of replying to Mr. Stokes' letter on the above subject, which appeared on page 90 of your issue dated November 5, 1927.

The Spun-Sorbitic process is different from the ordinary centrifugal process in the following respects:—

(1) It is operated in a different manner from the ordinary centrifugal process.

(2) It is applicable to more intricate cylindrical forms than the ordinary centrifugal process.

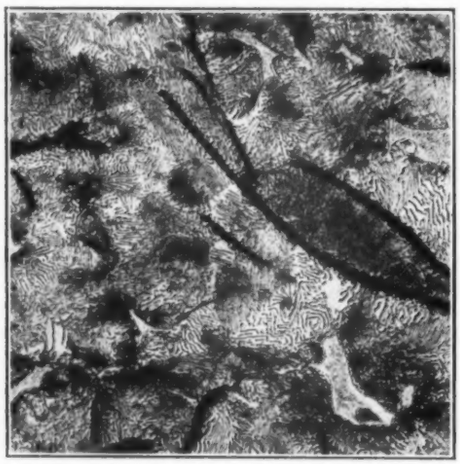


Fig. A.—Etched in Picric Acid × 200.

(3) Its product is different from ordinary centrifugal castings in both chemical composition, mechanical properties and structure.

(4) Its product is specially suitable for liners which have to work in conjunction with ordinary centrifugally cast piston rings.

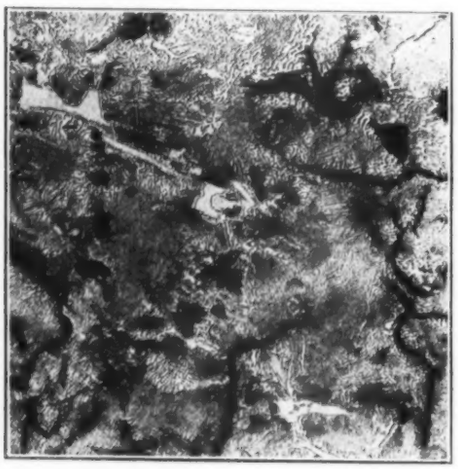


Fig. B.—Etched in Picric Acid × 200.

It is surely not difficult to understand that a process differing in so many vital respects should be given a separate name, and that this name should be related to the structure obtained in these castings.

It so happens that in the case of the particular photograph referred to by Mr. Stokes that I possess a photograph of exactly the same material centrifugally cast, but not *sorbitised*. I enclose this photograph, marked "A," together with the one referred to by Mr. Stokes, marked "B." The photograph "A," in spite of being centrifugally cast, shows the characteristic structure of the pearlite, *unbroken*. The photograph "B" shows what Mr. Stokes calls broken up laminated pearlite.

I take the liberty of enclosing a third photograph, "C," of exactly the same material as above, but completely sorbitised. This shows the apparently structureless character of the Spun-Sorbitic matrix. Such photographs do not generally reproduce well, and we have considered that the photograph "B," which sample gave a tensile strength of 28.9 tons per sq. in., sufficient for our purpose.

All these photographs are taken at the same magnification and etched in the same manner.

I hardly venture to hope that it is possible to trespass on your generosity and space to such an extent as the reproduction of these three micro-

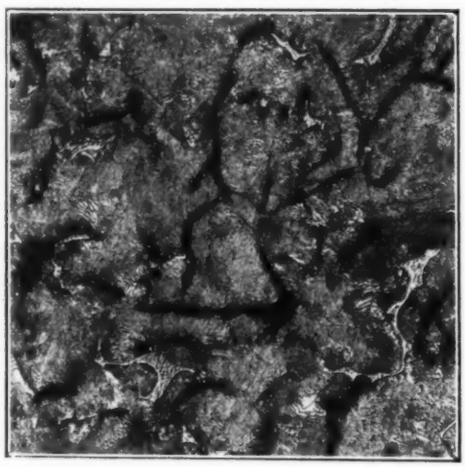


Fig. C.—Etched in Picric Acid × 200.

photographs, and you will retain the liberty of forwarding these to Mr. Stokes for his examination at your discretion.

Finally, I should be the last person to doubt that Mr. Stokes has spun some of the ingenious and fanciful materials mentioned by him in his last paragraph. I do express the hope that some of them, at any rate, he will not continue to spin.—Yours, etc.,

J. E. Hurst
(Newton, Chambers & Company, Limited).
Thorncliffe Centrifugal Castings Dept.,
Thorncliffe Ironworks, near Sheffield.
November 14, 1927.

Custom of the Trade.

To the Editor of The Foundry Trade Journal.

Sir,—I agree with your remarks in reply to "Kendor" in your issue of the 17th inst. It is the manufacturer's duty to see that his customer's patterns are kept in a good state of repair, or, of course, to notify his client of his difficulties.

The charging up of the machining is a much more important question, and I should like to hear the opinion of other foundrymen on this matter. As far as my firm is concerned, we make a large number of castings for the trade, and some buyers only expect the defective castings to be replaced, which is the recognised custom in the trade, but other buyers often try and charge up the machining expenses, which I think is a most iniquitous imposition.

If the National Iron Foundrymen's Employers' Federation can help us in the matter, I am sure it would be a great boon to us.—Yours, etc.,

M. D.

November 19, 1927.

Mr. D. W. Lennox, managing director of the Britannia Foundry Company, Limited, of Coventry, the well-known manufacturers of moulding machines, has invented an arrangement for effectively preventing the theft of motor-cars.

Random Shots.

We have been suffering of late from a plethora of "Reports on Economic Conditions," of which the ones from the United States and Germany have aroused the most interest. It is, after all, hardly surprising that we can raise no great enthusiasm for trade prospects in China at the moment. Nor is our zeal enhanced when we learn that the only hope of finding good markets there lies in careful personal examination of the field. When complaints come from America that we leave too much to representatives, and are too hesitant in making personal contacts and inquiries, it is hardly likely that we should be inspired, even in more peaceable times, lightly to undertake the distinctly longer journey to the Far East. A business trip to the States is, after all, becoming a commonplace, and if the prophecy of a three-day service across the Atlantic comes true it will cease to be any great undertaking. But China! That is another story!

* * *

The burden of the report from America is that there is small opening there for our heavy goods—markets for which are such a vital need—but that there are great opportunities in those branches of manufacture where individual quality and finish are of first importance. While this is but poor consolation to the would-be exporter of heavy goods, it is interesting to note that sports goods, especially fishing tackle, pipes, and men's wear of all kinds, offer an exceedingly promising field for the English trader. The English "cut" and "finish" in such goods, and in a multitude of others, is gaining great favour with a population whose every breath is drawn in an atmosphere of standardised mass production.

* * *

Talking of English cut and finish, men's clothing does not seem to be the only sphere in which it is gaining favour in the States. Anyone who is familiar—through the medium of the "movie" or otherwise—with the monstrous American railway engine can hardly have failed to be struck by the contrast between these denizens of the American railroad and the invader from England that recently astonished engineers over there by its record-breaking capacity. The creation of the English engineer, it appears, contrasts as effectively with its American counterpart as does the handiwork of a Savile Row tailor, for both spring from the same national characteristics.

* * *

But if the American report gives scope for flippant reflection, and is amply illustrated with picturesque details about coloured golf stockings and the glass-ware in use in service flats, the one from Germany is very different. Here is no picturesque detail, but highly relevant statistics and hard facts. The comparison of the two is an interesting example of the different angles from which such similar questions can be tackled by different people, as interesting in its way as the actual comparison of conditions in these two great industrial countries.

* * *

Reverting to the fruitful topic of English *versus* American cut, would it be quite fair to extend the comparison to the realm of motorists? When we discuss American cars there is one vision, and one alone, that floats before our eyes, however deeply we may query its right to the title of car at all, and however well we may be aware of the existence of numerous far more elegant specimens produced on the other side. No doubt we should like to feel that the foreigner thinks of the British-made car as typified by certain exclusive and elegant models that we all admire, while he knows nothing of our own home-bred oddities.

* * *

Certainly, to our prejudiced English eyes the product of Oxford, whatever its dangers to the beauties of our countryside, is infinitely more shapely and stylish than its distant cousin from Detroit, but even this superiority is not long to remain with us, apparently. We hear impressive stories of locked doors and armed guards surrounding workshop and laboratory, of world-shaking innovations and astounding quality.

Surface Hardening by Nitrogen.

By Nitride.

Considerable interest has been aroused recently, particularly in the automobile industry, by the possibilities of nitrogen hardening. The new process is the invention of Dr. Fry, of the Research Laboratories of Messrs. Friedrich Krupp of Essen.

Briefly, the process consists of subjecting the parts to be hardened to the action of ammonia gas at a temperature of approximately 500 deg. C. for a period of time varying from 40 to 120 hours. The ammonia is dissociated, and a portion of the nitrogen thus formed passes into solid solution in the outer layers of the parts. The parts, after removal from the furnace, are cased with a hardened layer, the outside portions of which are considerably harder than ordinary case-hardened work.

The steels used for this process are of a special character. Ordinary structural steels such as the nickel and nickel chrome steels undergo little increase in hardness by this treatment. Dr. Fry found that in steels containing aluminium and silicon, the surface layers reached a hardness of approximately 900 Brinell. The steels being used for this process, which is finding extensive application on the Continent, contain 1.5 per cent. of chromium and 1.5 per cent. of aluminium with a silicon content slightly higher than that usually met with in structural steels. A recent alteration to the composition consists in the addition of 1.5 to 2 per cent. of nickel also. This is said to improve the physical properties of the core and also to lessen the tendency of the case to chip or crack when subjected to shock, without materially lessening the hardness.

The carbon contents of the steels are varied from 0.20 to 0.40, according to the physical properties desired in the core of the finished parts. The steels present no difficulty in forging and machining, and the physical properties (after suitable heat-treatment) are very similar to ordinary nickel chrome steels. The steels are heat treated in the forged, rolled or rough machined condition to give the required physical properties. The most used steel is one which gives 50 to 60 tons tensile after heat treatment which is easily machined in this condition. The heat treatment consists of water or oil quenching at a temperature of 850 to 900 degs. C., followed by a tempering in the region of 600 to 670 degs. C.

Distortion Decreased.

One of the most notable and valuable features of the process is the small amount of distortion which the parts undergo during the nitrogen treatment. This is, of course, due to the low temperature of the process and the fact that no further treatment is required after the parts have been cooled down after being subjected to the gas. Provided that the steel is under no strain when put in for nitrogenising, practically the only dimensional changes which occur are a slight growth due to nitrogen absorption. This growth is quite regular, and can be allowed for in machining the parts. To take advantage of this feature of the process the heat-treated forgings are machined to within an $\frac{1}{8}$-in. of finished sizes and subjected to a further annealing to remove all strains set up by machining. This second tempering or annealing operation is conducted at a slightly lower temperature to prevent any alteration in physical properties. The parts are then finished machined completely, due allowance being made for the subsequent growth. It is not usual to leave any allowance for subsequent grinding for the reason that no appreciable or unallowed for distortion should take place and for other reasons which will be explained later.

Electric Furnaces Essential.

The furnaces in which the treatment takes place are electrically heated. This is on account of the close temperature control necessary and the fact that for this type of process, due to the low temperature and the long duration of the heat, electricity is easily the cheapest heating medium.

The furnaces are of the wire-wound type, the muffle itself being of non-scaling steel. The furnaces are very heavily lagged with diatomaceous earth and the radiation losses cut down to a very small amount. For instance, a furnace with internal muffle dimensions of 50 in. by 20 in. by 20 in. needs less than 1 kw. per hour to maintain it at the requisite temperature. The work is placed in boxes similar to ordinary carburising boxes, but with lids which can be bolted down with asbestos packing to make them gas tight. An inlet and exit tube are provided for the gases together with a tube for the insertion of a thermocouple to get the junction in the centre of the box.

Stainless Steel Boxes Used.

Due to the embrittling effect of very prolonged contact with ammonia gas at elevated temperatures on ordinary steels, the boxes are constructed from high nickel stainless iron of the "Anka" variety which is practically immune from deterioration by ammonia gas. The boxes have an indefinite length of life. No particular care is necessary in packing the pieces beyond ensuring a fairly free passage of the gas. It is not essential that the parts should not touch each other as long as the requirements as to free circulation are met.

Process Described.

The box is put into the furnace and the door opening made up with insulating bricks and asbestos to give nearly as good lagging in the door aperture as on the sides and back, and thus permit of even heating of the box. The furnace is then brought up to working temperature, which takes from 5 to 12 hours according to the size of the furnace and the weight of the charge. As soon as the working temperature is reached, the input of current is reduced to supply just that amount necessary to balance radiation losses. The ammonia gas is derived from cylinders holding either 50 or 100 cub. ft. Standard anhydrous ammonia gas, such as is made for various other industrial purposes, is used. The influx of gas is started as soon as the furnace warms up, and a steady stream is maintained throughout the heat. The quantity of ammonia gas is regulated so that a definite amount of dissociation takes place; this dissociation being measured by a simple analysis of the exit gases.

The maximum depth of "case" which is obtainable by this process is approximately 0.040 in. After the penetration has reached 0.032 to 0.034 in. the rate gradually falls off and stops altogether at about 0.040 in.

Nature of Hard Surface.

For a "case" of 0.020 to 0.025 in., approximately 50 hours at temperature is needed, and for 0.032 to 0.036 in. 100 hours are needed. This long period constitutes one of the disadvantages of the process. After the heat is finished the current is switched off and the furnace allowed to cool down naturally, the gas being circulated until the temperature has fallen to about 200 deg. C.

The pieces after removal from the box present a matt appearance, with here and there variegated violet markings. They have a soft skin approximately half a thousandth thick, and underneath this the hard nitrogenised layer. This soft skin is removed either by sand blasting or polishing.

The nitrogenised layer is intensely hard and quite incapable of being marked with any sort of file. Scleroscope readings usually give figures in the region of 107-112, and the diamond indentations test gives a Brinell hardness of about 900.

As would naturally be expected from the hardness figures the "case" is more brittle than ordinary case-hardened work, and for this reason sharp corners should be avoided on nitrogenised work. The growth which occurs on nitrogenised work is in the order of half a thousandth of an inch per surface. Although the total depth of case in nitrogenised work is in the order of 0.025 to 0.038, according to the length of time of the heat, the intensely hard portion, that is, that portion 850 to 900 Brinell, is only five or six thousandths of an inch deep.

Graduated Hardness Precludes Grinding.

Laboratory and service wear tests have proved that the wearing properties of the nitrogenised layer are in accordance with what one would expect from the Brinell hardness. In fact, in many cases they have proved even better. Wear tests on Amsler abrasion testing machine have shown the rate of wear to be approximately $\frac{1}{25}$th that which occurred with a nickel chrome steel case-hardened by ordinary methods. A Paper read at the recent Convention of the American Society for Steel Treating in Detroit on the wear of plug gauges gave similar figures for nitrogen hardened steel. Gauges hardened by this process gave an infinitely longer life than similar gauges made from ordinary case-hardened steels under all conditions of abrasion. It is interesting to note here, though, that under certain abrasive conditions chromium-plated gauges gave a longer life than nitrogen hardened gauges, whilst manganese steel gave very poor results for this particular duty.

Applications Tested.

Many of the leading automobile concerns in France have had parts hardened by this process under service tests for a year or two, and the results have been, almost wholly, entirely satisfactory. It has been used with success for crank-shafts and cam-shafts. These are parts where considerable trouble is caused through distortion in case-hardening and satisfactory wearing properties cannot be obtained without large bearing areas.

Valves stems and timing gears have also proved a very successful field for the application of this process. Plug gauges and screw gauges have been more accurately made, and have a longer life than when made by any other process, for as yet chrominum plating has not proved suitable for screw gauges owing to the unevenness of the deposit. There is no real limit to the size of the parts which can be treated by this process, the only limitations being box and furnace capacity. Probably the largest part treated so far is a gear wheel rim 4 ft. 10 in. diameter by 20-in. face, which has given remarkable results in service.

Disadvantages.

The disadvantages and limitations of the process may be given as follows: Initially, the cost of the special steel necessary for the process is rather high. It is an electric furnace steel and approximates in price to a good quality electric furnace nickel-chrome case-hardening steel. It is possible that with extensions of the process and improvements in manufacture this price may be reduced. The long period necessary for treatment is also rather a drawback, the complete floor to floor time being nearly a week for the full depth of case.

Also, it is possible that due to the extreme hardness of the case trouble may be caused through severe shocks, especially on the edges of the work.

Furthermore, it is not certain how such parts would behave under conditions of loading involving very heavy surfaces pressures. It should be remembered that case-hardening steels with core strengths of 90 to 95 tons are being fairly regularly used in the automobile industry now and superimposed upon this is a carburised case of anything up to 0.050 in. deep.

Whether nitrogen hardened parts with a maximum machinable core strength of 60 to 65 tons and a case 0.030 to 0.038 in. will stand up without indentation under such conditions remains yet to be proved. The advantages of the process are the excellent hardness and the wearing properties of the case and the very slight distortion even on most intricate parts. There are many parts which have been treated by this process successfully where ordinary case-hardening methods were totally inapplicable, due to the delicacy and intricacy of the parts and the tremendous distortion which took place when such methods were tried.

Another feature of this process which warrants attention is that the hardened case retains its full hardness up to a temperature of 500 deg. C. Altogether, the process appears to be one with considerable possibilities, and deserves the attention of all engineers interested in case-hardened work. It should be mentioned that the process is fully protected in all countries.

Loam Moulding.*

By W. Holland.

In the production of large castings loam moulding is carried out to a greater extent in certain districts of the British Isles than in others. Castings, such as large turbine cylinder parts, often made from skeleton patterns, are moulded in dry sand, yet the same patterns sent to another foundry, would be bricked up in loam. This, of course, is left to the discretion of the manager in whose foundry the castings are made. Also much depends upon the lay-out of the foundry and the tackle they have at their disposal—cranes, bolting down facilities, etc.

It is essential that a loam moulder should have a good knowledge of drawings, as by continual reference to these he is enabled to visualise the complete construction of his mould. By viewing the mould from different angles, he is assisted in executing his work with greater facility.

Large castings, such as cylinders, propellers, turbo-generators and condensers are produced in loam without the use of full patterns. It may therefore be of interest if a brief description is given of the making of a propeller, as for some of the larger boats these castings measure 17 ft. across the blades from tip to tip.

Making a Four-bladed Propeller.

In making a four-bladed propeller the method adopted by some foundries is as follows:—

Where the castings are produced regularly the necessary large cast-iron bottom plate, with holes cast in for bolting down the complete mould when finished, is a fixture in the floor. The cross or centre, which is for the spindle, is a fixture also under the bottom plate. The spindle is usually about 6 in. dia., and this is set in the centre. On to the spindle is then bolted a collar. Also over the spindle and resting on the collar is an arm, attached to which is the board for striking up the seating for the centre boss, also for striking up the seating for the skeleton rail pattern to rest on for the purpose of striking up the four beds of the propeller blades. These seatings are now struck up in loam and bricks, stiffened with fires and equally divided off.

The seating board is then taken off, and the board to form the dummy boss of the propeller is bolted to the arm. Next the dummy boss is bricked up, stiffened with fires, slipped up with soft loam, and the board taken off again. The skeleton rail or pattern to form the right sweep of the blades is then set at one of the four centres on the outside seating, and is weighted down into position.

Another board is then attached to the arm. This board is used to strike up the face of the beds working on the outside rail pattern. Also on this board there are nails projecting to mark off centres to place the skeleton thickness pieces to form the thickness of the blades.

Spindle Tackle.

At this point it might be advisable to describe more fully the spindle tackle. Usually at the top of the spindle there is a bracket which is made to hold a grooved pulley, the latter being constructed to fit into the top of the spindle. Over this pulley there is a chain, the one end of which is attached to the arm holding the bolted board, whilst the other end is attached to a weight. This facilitates the easy working of the board in striking up the beds.

The first bed having been bricked and slipped up with soft loam, the rail pattern is moved to the next centre, and the procedure repeated until the four beds or sweep of the blade are constructed. The blade thickness pieces are then set on to the centres marked on the beds, and between them black sand is filled in and rammed and strickled off to form the pattern of the blades on the beds.

Making the Top Copes.

These are usually made with two bows over each blade. The bows are so made to follow the contour of the sweep of the top of the blades, holes being cast in to allow bars going through. Also snugs are cast in for lifting purposes. These bows are placed in position on the beds, over the sand patterns, usually on iron boxes or stools built in the beds.

Bars are then put through the holes on the bows and wedged in. The next procedure is to brick through the bars. The four copes having been bricked up, it is usual to build up a fire between the beds to stiffen the copes, and, this done, they are lifted off and sometimes turned over. The sand pattern is taken off the beds and dummy core which is forming the boss is also taken out. The whole mould and copes is finished off, blacked, and thoroughly dried.

The mould is then assembled, the copes being put back to their marks, and the centre core placed into position. When the top plate has been put over the boss with the necessary runners and risers in, the whole job is cramped and bolted down. Generally crib plates are placed around the mould, rammed up and cast.

In conclusion, the author desires to thank Mr. S. G. Smith, of Manchester, for the loan of the slides.

* Paper read before the Burnley Section of the Institute of British Foundrymen. The author is on the staff of Messrs. Thos. E. Gray & Co., Ltd.

I.B.F. Branch Presidents.

No. 5—Newcastle Branch.

Mr. Stobie was born in Birmingham in 1880, educated there and in Paris. He studied metallurgy under Professor Arnold, and electrical engineering under Professor Ripper, at Sheffield University. He established works in Sheffield in 1906 to operate the Stobie patent annealing process, which was the first non-scaling annealing process applicable to, at one operation, 20 tons or more of long tool steel bars without bending. The majority of Sheffield steelworks sent their tools and alloy steel bars to be treated at those works, which Mr. Stobie ultimately sold on establishing new steelworks at Dunston-on-Tyne in 1913.

Mr. Victor Stobie.
(President of the Newcastle Section of the I.B.F.)

During 1910 he installed at his Sheffield works the first British designed and built electric steel melting furnace. This furnace was designed by Mr. Stobie at the request of Electro-Metals, Ltd., who controlled certain Swedish patents which were incorporated. It is interesting to note as an indication of early beginnings in steel electro-metallurgy that the holding capacity of the furnace was 2½ tons, and its electrical capacity only 400 kw., with a maximum of 60 volts per arc. As a comparison, recently-designed Stobie furnaces have a wattage of thrice the above per ton of steel melted, with a voltage of 125 per arc. A small open-hearth furnace was used later for supplying molten steel for "finishing" in the electric furnace.

At the Stobie Steel Company's new works at Dunston-on-Tyne, Mr. Stobie designed and installed electric steel-melting furnaces, based on his own patents, on a large scale, which was considered at the time by many expert steel makers to be an "optimist's fatal plunge." The largest furnace had a holding capacity of 12 tons, afterwards increased to 15 tons, with a normal input of 3,000 kw., or about 4,500 h.p., with overload capacity to 6,000 h.p. At that time, the nearest size electric furnace working elsewhere was a 15-ton one at Chicago, but that one dealt only with Bessemer rail steel delivered to it molten, and was, therefore, of much lower electrical capacity. The furnaces proved a success, and an output of over 1,000 tons per month from the largest one became normal working. Since that date many furnaces on similar lines have been installed in other steelworks. To-day various types of Stobie furnaces are working in Great Britain, U.S.A., India, Sweden, Germany and Poland on steel, iron, copper and silver, and in the sugar industry.

In 1915 and 1916 experiments were undertaken by Mr. Stobie, which ultimately led to the perfecting of the Stobie Patent economiser, which reduced the current electrode and refractories consumption of electric furnaces by some 20 per cent. and permitted better control of the chemical reactions in the furnace. As is sometimes the case in such researches the first fruits of the innovation were an *increase* in consumption! The economy was established ultimately when the conduct of the melting process was radically altered to suit the unsuspected new chemical conditions.

Another interesting research undertaken by Mr. Stobie (in 1918) was in regard to the existence, or otherwise, of a circulation of molten steel in an electric furnace. Most electric steel melting furnace builders had stated that such a circulation existed in electric arc furnaces, but Mr. Stobie's experience did not appear to warrant that conclusion. The research was carried out in model arc furnaces which incorporated every type of electrical system on the market—and a few others which suggested themselves. The full details are to be found in the transactions of the Institute of Electrical Engineers, but the result may be shortly stated as having finally disposed of a wrong suggestion which had clouded many a serious consideration of electric furnace operations.

The use of anthracite for carburising the molten steel in electric furnaces was first carried out at Mr. Stobie's Sheffield works, and is now standard practice in the industry. Other early work he did in electric furnaces were the reclaiming of tungsten from high-speed mill scale into a bath of steel (1911), and reduction of chromium from chrome ore into molten steel (1916). The latter process which, thereafter, was regularly used at the Stobie Steelworks in the manufacture of ball-bearing steel is now in use in many works for making stainless steel.

In 1917 the Admiralty had encountered trouble with low transverse tests on torpedo air tubes, due to silicate of manganese present in the alloy steel used for the purpose. Mr. Stobie was approached in the matter and ultimately produced steel which, probably for the first time in the art, contained no slag inclusion whatever, thus disposing of the belief, until then held by metallurgists, that alloy steel could not regularly be produced without such inclusion. Details were made public after the War.

He read Papers before the Iron and Steel Institute, the Institute of Electrical Engineers, the West of Scotland Iron and Steel Institute, the Cleveland Institute of Engineers, the Sheffield Society of Engineers and Metallurgists, and the Institute of British Foundrymen, of which institutions he was a member.

Outside metallurgy, he holds patent rights for useful inventions in kinematography, radio-telegraphy and astronomical telescopes.

The Prevention of Accidents in Foundry Work.

By J. E. P.

There are less accidents now in foundries than there were thirty years ago, and in this improved condition science has played a part.

A cause of many accidents is the failure of those in authority to instruct workmen in the safety methods, and insist upon those methods being carried out.

It is the object of this article to indicate the causes of accidents and their logical avoidance.

Insufficient Light.

There should always be ample light in foundries, especially at pouring time, so that the men can properly see what they are doing. Foundries, even at their best, are liable to have things littered about which obstruct the men's free passage as they are carrying the molten metal about. In semi-darkness the least obstacle lying upon the ground may cause a caster to stumble and spill the metal, with, perhaps, serious consequences. Light, more light, is necessary to allow the men to see the stacks of moulding boxes, old scrap castings, core-barrels, patterns, heaps of sand and rubble, etc. Apart from the obvious danger it is difficult for the men to do their work properly without adequate light. The very material with which they work is black, therefore the better the light, the better—to a large extent—the work. Even to-day there exist foundries which are grossly inadequately lighted. It may surprise some readers to know that in these foundries candles, and the old-fashioned "Aladdin lamps," made of cast iron, burning paraffin oil, and giving off a thick smoke, are used during the normal day-time. Small wonder it is that accidents occur in such conditions, or that bad castings are produced.

Boots.

It is very bad policy to allow men and boys to carry molten metal when their boots are dilapidated, or even if their boots are in a fairly good state of repair, their laces may not be properly tied. Lace boots, of course, are unsuitable for foundry work; not only does the sand and dirt get to the feet but splashes of metal will easily get through the lace part. Many accidents have so occurred, and still occur. The best kind of boot for foundry work is the old-fashioned "Blucher," with block front, or better still the "Wellington." There have been fewer feet burned when either of these are worn than with any other. The spats provided by some firms for their casters are a step in the right direction, but they are very cumbersome, not easily put on, and seldom a sure preventive against splashes. The ideal boot for foundry work has yet to be invented; it must while giving absolute immunity from splashes, also give comfort to the wearer, and be presentable when out of the foundry.

Catching and Carrying.

That there are many accidents during these operations will not be disputed, yet with proper and timely instructions and a reasonable amount of care many could be avoided. The system of catching metal from the spout still prevails in many foundries, and unless this is performed intelligently there is always a mess by splashing, and the chance of someone getting burned. The hand shank should be slightly tilted so that its lip can cut through the stream of metal. If it is not, the metal will strike the outside, and splashing must occur, to the danger of all standing near. The same tilt should be given to the shank in backing out, by this knack of dipping in and out there need not be the slightest splashing. The shank must not be quite full, so that the carrying will be better, and there will be less spilling.

The men carrying must step in unison, either running or walking. There is a peculiar swing to be given to the shank of metal which can hardly be described, but can be acquired by practice, and it is wise to have some trial runs with an empty shank. It is a good method to train a gang of men to do this work, and not let anyone else touch the ladles of metal, as even the pouring of the moulds can soon be accomplished successfully by trained casters.

A very good system exists in some foundries, that of tapping into 10 cwt. or 20 cwt. ladles and conveying the metal in these to the various casting sections, and serving out from them. Quite often there is spare metal which is generally poured on the floor into pigs. On no account should this metal be covered, as the live metal under the covering of sand cannot be seen the men may step into it with very serious results.

Crane Ladles.

All crane ladles, whether of 5 cwt. or 50 tons capacity, should have turning gear and safety catches attached to them. There is very great danger to all concerned in the foundry when molten metal is being carried about in a crane ladle which is not geared, or when the gear is out of order. Unfortunately the same care and inspection is not given to foundry crane ladles as is given to machinery in other departments of the works. Sometimes the worm and wheel are so badly worn that they do not engage properly, and in consequence when the pouring operation is in progress, there is either a big drop in the angle of the tilt, or perhaps a jam in the wheels, when several men are required to turn the ladle past this tight place. In both cases the rush of metal—caused by the sudden turn of the ladle—will gush over the runner basin, and even if it does not burn anyone will certainly make a mess of the mould.

Ladles without gears are most difficult to hold, more especially in transit; there have been some serious accidents by such ladles getting out of control and turning over when full of liquid metal.

All crane ladles should have vent holes drilled all over them. This is a very good safeguard against explosions.

Every foundryman has seen—at one time or other—metal bubbling and blowing in the ladle, more so when the metal is tapped into a newly lined one. This is caused by the lining not being dry and there being no vent holes in the ladle to take off the steam from the undried lining. Of course all ladle linings should be perfectly dry, but there are times when they are not quite dry, and therein lies the danger. It is much easier to daub a ladle with vent holes in it, than without, as there are no strands of straw or string required to make vents, and the ganister can be just daubed on to the ladle. Much less time is taken in the doing, and all will be safe even if the lining is not quite dry; steam and sometimes even water has been seen trickling out of the vent holes of a newly lined crane ladle, yet no explosion or even bubbling of the metal has occurred.

Stacking Moulding Boxes.

Generally speaking there is not enough space in the foundry yard or the foundry itself to stack out-of-use moulding boxes, so they are piled up haphazard anywhere to the peril of all working or passing near them. Those stacked inside the foundry are particularly dangerous; sometimes these boxes are piled one on top of another until they reach an alarming height, and as the ground upon which they are stacked is not of a firm, solid character, there is the possibility of its giving way and the whole lot come toppling over. This sort of accident has happened more than once to the writer's knowledge with disastrous results.

If moulding boxes must be stacked inside the foundry the ground should be made firm and solid, using, for instance, an old loam plate. Care should be taken to put down the first box fairly level, the subsequent ones should not be squared upon it, but should be staggered.

Fettling.

Fettling inside the moulding shop is definitely undesirable. Apart from the danger of flying chips of metal, there is the rubble from cores and the spent sand from the castings, getting into the moulding sand, lowering its binding property and causing moulds to collapse.

In cases where it is impossible to take castings out of the foundry to be fettled, portable screens should be provided, to arrest the flying chips. Such screens are quite inexpensive and are quite effective. In the fettling shop the walk should be lined with wood and the chipping done near to it, so that all chips will be directed—more or less—toward the wood, which will lessen their speed and so make it safer for all working near.

Rusty Rods.

It is perhaps somewhat astonishing to know that even in this enlightened age, rusty feeding rods are thrust into live metal and rusty or damp skimmers used for skimming off slag.

Everybody ought to know that as soon as these rusty or damp things touch the liquid metal there is an instantaneous explosion, so rapid indeed, that the men have no time to get out of the way of the flying metal. Rust consists of iron oxide and water, and when plunged into molten metal there is immediately generated an infinitely larger volume of steam causing an explosion. Live metal should never be touched with anything rusty, damp, or cold. All feeding rods must be warmed and all skimmers cleaned, blacked and dried before using.

Water.

The writer has seen a top part of a mould weighing several hundredweights, blown up 3 or 4 in. and the metal gush out all round about the men's feet. When men are making up the runner basin they will utilise too much water round the top so as to fix any loose sand. This is a really dangerous practice; should any metal touch those wet places a small explosion occurs, pellets of metal being shot up amongst the men. Water is put on the edge of a mould to prevent the sand from breaking while the pattern is being drawn out; it is also sprinkled on the mould so that the mould can more easily be finished, but great care and discretion must be used or disaster will follow if the mould is to be cast green.

Weights.

It is quite common to find insufficient weights for use, particularly small ones for weighting down the moulding boxes, so that at pouring time the weights have to be changed from those moulds cast to those to be cast. This has led to many foundrymen being very badly burned on their feet, by removing the weights too soon. Changing weights in such conditions is always fraught with danger; plenty of time should be given for the metal to set.

Cupola Working.

With the average amount of intelligence in working the cuopla, there should be no accidents. If a solid bottom cupola is in use the bottom should be well cleaned after each blow, or cast, all metal and slag should be drained out and the refuse raked out. Should this be neglected it will become so hard and solid that it is almost impossible to remove it next morning. This generally leads to the first metal melted becoming so sluggish as to be very difficult to tap, even if it does not set in the tap hole. Should it so set, it often leads to accidents, as in trying to pierce this solid bone of metal, or drift it back through the tapping hole, the men invariably disturb the surrounding ganister, making the hole much larger than it should be. Then it is very difficult, if not impossible, to control the enlarged stream of metal. It is at such times as these and in such circumstances that bad accidents occur, as the stream of metal—if it cannot be stopped or controlled—will rush out quickly, filling the ladle and run over it on to the floor. This has happened and men have been burned, to say nothing of spoiling the ladle and wasting the metal. If the cupola has a drop-bottom, care should be taken to rub a little black or floor sand in the joints of the doors. The sand for making up the bottom should be floor sand and not new sand. In dropping the bottom after the day's blow, 2 or 3 in. of soft sand should be placed upon the ground for any metal and liquid slag to fall into.

for a very bad accident happened when this precaution was neglected.

Three golden rules to remember in cupola practice to lessen the possibility of accidents:—(1) all ganister round the tapping hole sound and dry; (2) tuyeres kept clean; and (3) coke not forgotten.

Sundry Tackle.

All cast-iron lifting beams should be scrapped. In many foundries there still exists the old time cast-iron lifting beams, which are never safe, particularly so in frosty weather, for then they sometimes snap in two like carrots, even with a light load. At best it is difficult correctly to estimate the weight of the mould, or the lifting capacity of the beam, even if one had the time to do so. Steel beams are quite safe, and these only should be used in the foundries.

Cast-iron clamps have often been the cause of accidents. Recently a large ingot-mould was being cast when the cast-iron clamp snapped and all the metal rushed out of the mould and very nearly trapped one of the workmen. Instances could be enumerated of similar cases, some with dire results. Mild-steel clamps are much safer, but even these should be carefully inspected before using.

Wrought-iron S hooks are a great source of danger, and it is surprising to know that they are still used in many foundries. In nearly all cases the crane hook will serve. It seems that a habit has grown up of using the S hook generally when lifting large ladles of metal; the men just put it on without thinking whether it is really necessary. Were they to use a little intelligence they would soon realise that the crane hook would go through the stirrup hook of the crane ladle. Even when an S hook is found to be necessary, a snaffle catch should be attached to it as a means of safety.

A large loam mould was once being lifted when a S hook was used, the mould was up about 2 ft. 6 in. when the moulder got under to anchor one of the cores to the foundation plate. The foreman passing at the time realised the terrible danger, and, with commendable prompitude, pulled the man out by his feet. The very instant the man was clear the S hook broke, and the whole lot—weighing over 15 tons—crashed to the ground. Even when all tackle is considered to be quite reliable and safe, the men should not be allowed to get under a mould until these moulds have been securely propped from the ground.

Enough thought is not usually given to the lugs of loam-moulding plates. They are not made sufficiently strong to carry the heavy loads they sometimes are expected to take. Invariably the total load is not equally distributed, consequently, when more weight is thrown on to one lug, by bad arrangement of lifting chains, it will snap, then the whole mould will collapse. It is good practice to make the lugs extra strong, and place a piece of wood under them for the chain or stirrup to bite into, and so take an equal pressure on all lugs; these pieces of wood under the lugs will neutralise any unevenness on the under side of the lugs, and also prevent the chain from slipping.

There are many cast-iron trestles still in use in the foundries which ought to have been scrapped and relegated to the cupola years ago; frail, flimsy things that will scarcely stand up without some sort of support, much less carry the hefty weights sometimes put upon them. A top part of a moulding box was once put upon such trestles, which, chiefly owing to haste, and the soft sand they were placed upon, collapsed, and caused a man's death. Trunnions, when cast on moulding boxes, should not be used to lift large, heavy boxes when rammed up. It takes a little longer to fix chains to the wrought-iron handles, but it is a far safer method. Trunnions should only be used for light weights to be turned over with roller slings, or turned over on trestles. A far safer plan is to cast a square hole in each end of the moulding box and fit a mild-steel trunnion to them, fastened with a cotter or nut. These are perfectly safe, and will last much longer.

General Comments.

In well-organised foundries accidents are far less frequent, and production increased. The layout should be such that will enable the men to do their alloted task with the least possible risk to life and limb; sufficient floor space should be apportioned to each moulder, so that at casting time ready and easy access be given to the caster. Moulds should be so placed that runners are toward the gangway, and in line. All gangways should be kept quite clear of obstructions, not only along the casting line but also from the cupola to the moulds. Proper facility should be provided for conveying castings from the foundry to the fettling shop, also for moving moulding boxes and loam plates to and from the foundry. A system of narrow-gauge trolley track is good for this purpose, and it ensures a permanent gangway and floor line.

The proposed order to instal safety-first officers in foundries is ridiculous, unless he has either been long trained in foundry practice or has such a personality that he can control the foundry foreman and his charge hands "without treading on their corns." As a practical man of long experience the author can state that if a safety officer can make a foundry as safe as humanly possible, then he can do foundry foreman's work, and inversely if a foundry foreman or manager is worthy of his position he can, with advantage to everybody concerned, fill, and adequately fill, the dual office of controlling the department and rendering it "safe."

Most factory inspectors are deplorably ignorant of foundry work. It is very annoying to see them floundering about, wanting various machines fenced in, such as a tumbling barrel, or a pan mill, etc. A power moulding machine was once expected to be enclosed by fencing; to have done so, and have worked it, the moulder would also have had to have been enclosed with it.

Elementary Micro-Analysis of Pig-Iron.*

By H. Cowan, B.Sc.

In view of the relatively high cost of chemical analysis and the fact that the time taken for an analysis is often inconvenient, the following brief notes have been prepared to aid the iron founder to interpret his observations on the fractures of pig-iron. The sample cut away should be about ½ in. sq. and filed in the ordinary way until one side is quite flat and finished on a dead-smooth file. Sharp corners and edges should be removed, so that the emery papers subsequently used will not be torn. After filing, the specimen is rubbed to and fro on several different emery papers, each paper being finer than the one preceding it. These ordinary fine emery papers are then followed by French emery papers, 0, 00, 000 and 0000, which are stretched over a piece of hard wood, or similar hard, flat surface. It may be found possible to discard the two last emery papers after a little experience has been gained. It is important to note that each emery paper is used until the scratches made by the previous one have been eliminated. This is best obtained by turning the specimen through 90 degrees at each transfer. After the final emery polish it will be seen that only microscopic scratches are visible, and these can be removed by polishing the specimen finally on a polishing cloth (wash-leather is quite good), moistened with water containing jeweller's rouge in suspension. With the aid of a good pocket lens, the graphite in the specimen may be examined.

The phosphorus content of a pig-iron is often of the greatest importance, whether it is relatively high, medium, or low. The actual phosphorus content, given to so many decimal places, may be quite unimportant. An examination of the fracture of a sample of pig-iron for a quantitative estimation of phosphorus is useless, but since the phosphorus in pig-iron is segregated throughout in small isolated masses, it is clear that the total volume of these small masses in a given volume of pig-iron will have some close relation to the proportion of phosphorus present.

Iron phosphide is not affected by dilute acids, whereas the metallic portions are readily attacked and darkened. If, therefore, a sample of pig-iron, polished as described above, is dipped for about one minute into a dilute solution of nitric acid and afterwards thoroughly washed in running cold water and dried either by means of air-blast or a piece of cloth, the surfaces of the minute masses of iron phosphide will still remain bright, whilst the remainder of the surface will be quite black. The appearance of the surface of the sample will resemble bright spots on a dark background; the greater the phosphorus content of the iron the greater will be the area of the bright spots. This method, therefore, affords a rough means of distinguishing low-phosphorus iron from high-phosphorus iron. If a series of such etched specimens be collected from different pig-irons whose phosphorus contents are known by chemical analysis, it is possible to estimate the phosphorus content of an unknown pig-iron with a reasonable degree of accuracy by comparing a polished and etched sample of the pig-iron with the *similarly prepared* specimens of known phosphorus content.

Sulphur is another element, the rapid and easy estimation of which may be extremely useful. For this estimation a section about 1 in. square is advisable, and the polishing of the specimen need not be taken beyond polishing with French emery paper 000. The polished specimen of pig-iron is placed in careful intimate contact with a piece of ordinary photographic bromide paper which has been previously soaked in a 3 per cent. solution of sulphuric acid in water. Contact is maintained for a definite period of time, say 60 secs. The result of this contact is revealed as a brown stain on the paper, the depth of tint being approximately proportional to the sulphur content of the pig-iron. In carrying out this test the bromide paper, having been soaked in 3 per cent. sulphuric acid, is placed upon a flat surface of wood or glass. The polished surface of the pig-iron is washed with a little alcohol, dried with a piece of clean cloth, and then placed upon the bromide paper for exactly 60 secs. from the moment of contact. Once contact has been made under no circumstances whatever must the paper or pig-iron be moved relatively to one another. Afterwards the stained paper is rinsed under the water tap, and if it is desired to keep the sulphur print for any length of time it must be then transferred to a solution of "hypo." No dark room is required.

* Bulletin of the British Cast Iron Research Association.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

National Collection of Slides.

To the Editor of The Foundry Trade Journal.

Sir,—With reference to the suggestion made by Mr. Meadowcroft in your issue of November 17, I should like to point out that the Cast Iron Research Association has, as part of its information bureau and library, a small collection of lantern slides and is, in fact, equipped to make its own slides. The Association is also prepared to receive, index and arrange slides referring to any aspect of foundry practice, and to loan any of these in the way suggested.

Mr. Cameron and myself have, for example, undertaken to deposit prepared slides in this way. The time may come when similar arrangements may be made for cinema films.

Any slides may be sent to the Association, at 24, St. Paul's Square, Birmingham. May I also take this opportunity of adding that the library has an increasingly large and valuable collection of books, periodicals and patent specifications on cast iron and foundry practice, and contributions of new material and historically valuable material are welcomed.—Yours, etc.,

John T. Goodwin,
President, Institute of British Foundrymen.
Chesterfield, November 22, 1927.

Yorkshire and Lancashire Foundrymen Visit Large Gear Works.

The Metallurgy of Gear Manufacture.

An interesting joint gathering of the Lancashire and the West Yorkshire branches of the Institute of British Foundrymen took place on November 5, when between 150 and 160 members assembled at the works of Messrs. David Brown and Sons, Limited, gearing specialists, Park Works, Lockwood, Huddersfield.

In charge of the parties were Mr. W. Parker and Mr. S. W. Wise (President and Secretary, West Yorkshire branch); Mr. J. S. G. Primrose and Mr. H. Stead (President and Secretary, Lancashire branch). Mr. Tom Makemson, General Secretary of the Institute, was also with the party.

The visitors were shown everything that this famous undertaking has to show in the way of gear production from the earliest treatment of the metals to the beautifully finished product. The visitors were first shown through the tool room, from there to the extensive clerical, drawing, publicity, filing, and corresponding offices and the research department; then through the metallurgical laboratory, the pattern shop, the various departments for large and small gear and worm cutting, a special department for automobile gear cutting, the cutting and erecting of gears for all sizes of turbines, speed reducing and increasing units, etc. Special attention was given to the firm's speciality, phosphor-bronze gear wheel expanded on cast iron centres.

In the foundries the visitors were particularly interested in the sand-mixing plant, the reverberatory furnaces, and the casting of gear-wheel centres, for the phosphor-bronze rims, by a centrifugal spinning process. Finished moulds and warm castings, large and small, were seen. There was an interested inspection of the sand-slinger. The visitors finally viewed the muffle furnaces, case-hardening stoves and tanks and the annealing equipment.

After a thorough inspection of the works, with lucid descriptions of the plant and its operations by guides who had the ability to convey the information in sufficient detail, though necessarily brief, the visitors gathered in the firm's Welfare Department for tea, as the guests of Messrs. David Brown.

MR. W. PARKER, proposing thanks to the firm for their hospitality during the day, said neither Messrs. Brown nor the members of their staff had spared time or effort in giving the visitors a thorough insight into manufacturing operations of this great undertaking, and the relationship of the ironfounder's own particular obligations to the work in general. They had had a remarkable illustration of what could be done by well-organised quantity-production methods, and they had undoubtedly seen some extremely fine casting work, both by the firm's special centrifugal method of casting and by the ordinary sand moulding method. The reputation of the firm of David Brown and Sons, Limited, was world-wide and the visitors that day had seen ample reason why it should be so. Mr. Parker said he would like to couple with their thanks to the firm a special appreciation of the capable manner in which the members of the staff had acted as guides.

MR. J. S. G. PRIMROSE, seconding the motion, said he was sorry the directors of the firm had been unable to be present to hear how highly the visitors appreciated the kindness they had received that day, but they were glad to have Mr. F. W. Rowe, the firm's chief metallurgist, who he was sure would convey to the directors the warm thanks of the visitors.

MR. ROWE, acknowledging the thanks on behalf of the firm, said Messrs. Brown were rather proud of their undertaking, and he thought they had justifiable reason for that pride. They were the largest gear-cutting undertaking in the world, and they had gained a reputation which meant that they must produce nothing which would fail to live up to that high repute, and therefore he thought they really had something well worth showing to visitors. It was a privilege and a delight to have as visitors a body of such keenly interested men.

The visitors, after tea, adjourned to the large recreation room on the top floor of the Welfare Department, where Mr. F. W. Rowe gave an address, illustrated by lantern slides, on "Metallurgy in Gear Manufacture."

Prior to the lecture MR. MAKEMSON addressed a few words to the large gathering, and stressed the recent appeal of Mr. Goodwin, President of the Institute, to every member to make a really serious effort during the year to bring in at least one new member. The financial position of the Institute, said the speaker, was quite good, but the cost of organisation and administration was considerable, and at present was somewhat in excess of the income, and it behoved the members to correct that position as quickly as possible by increasing the membership so that the income would be much greater proportionately per head than would be the expenditure.

METALLURGY IN GEAR MANUFACTURE.

In the course of his observations on the subject of metallurgy in gear manufacture, Mr. F. W. Rowe said a brief consideration of the duties involved would show how great a part metallurgy and metallurgical principles played in the manufacturing of all classes of gearing. The universal requirements of any class of gearing were that it should run quietly in service, transmit the power with a minimum of friction loss, undergo minimum wear, and thereby have a long life, and have the necessary margin of strength to withstand contingent overloads. Methods of securing these objectives varied somewhat with the class of gearing and the size, and therefore no dogmatic rules could be laid down. The simplest form of gearing was, naturally, straight-toothed spurs. Where the size of the gear was of no great import or where the loading conditions were light, these spurs were made of cast iron. The founding of cast-iron gear wheels, whilst not presenting problems as serious as those encountered in hydraulic engineering or internal combustion-engine manufacture, provided, nevertheless, a fruitful field for the application of metallurgical principles.

Cast-Iron Gears.

Cast iron for machine-cut gears must have the maximum hardness consistent with good machining properties. If gear blanks were too hard, or if the hardness varied in different portions of the wheel, really accurate machining was not practicable; and the value of increased wearing properties due to greater hardness was nullified by the unequal distribution of load due to inaccurate machining. It had been found from experience that the best wear resulted from an iron containing the minimum amount of graphite carbon, and attention had to be paid to this point as well as to the amount of combined carbon. In general, said the speaker, they aimed at about 0.6 to 0.7 per cent. combined carbon, and kept the total carbon as low as possible. The composition of irons for gear wheels varied with the different sizes of the wheel, but in general they did not run to any extremes in regard to silicon and total carbon. For the average work they got good results from about 1.6 to 1.8 per cent. Shrinkage troubles were liable to be accentuated with a very low total carbon. In his own practice they kept the phosphorous content within reasonable proportions—within 0.8 and 0.9 per cent.—on account of its effect on shock-resisting qualities.

As would, he supposed, be anticipated, the best wearing iron was that consisting of a eutectoid matrix—that was, where no free ferrite was present and the combined carbon was approximately 0.90 per cent. It was rarely possible, however, using ordinary founding methods, to have metal of this composition in the actual teeth of a gear wheel, as the portion in which the teeth are subsequently cut was usually the heaviest, and if the composition of the metal were such as to give a eutectoid base in this area a considerable amount of free iron carbide would be present in the lighter parts of the wheel. Composition of the cast iron was, to a large extent, influenced by the shape and size of the gear wheel, both as regarded obtaining a suitable structure in the toothed portion and obtaining satisfactory casting properties. The problem of casting H-arm wheels was one that needed care, particularly if the pitch of the teeth was large and the tooth depth over 1 in. The thin arms adjacent to the heavy rim caused a contraction cavity to be present unless suitable precautions were taken. Many gear makers, to avoid trouble in this direction, made it a practice to core out the back of the H-arm, but this was a practice which, in the speaker's view, was not to be commended, because the strength of the wheel was very seriously reduced by attaching the arms by only $\frac{2}{3}$ of their section. Careful attention to the quality of the iron, the melting and pouring conditions, and the use of denseners at the arm ends would eradicate any cavities or porosity due to liquid contraction. If the denseners were too wide or too heavy, whilst they would certainly remove porosity from the arm ends, they would cause porous spots between the arms, and a good deal of careful experiment was necessary to formulate sizes suitable for every type of wheel.

Composition Limits.

Cast iron varied, of course, in its tendency to contraction, cavities depending on the method of melting and the composition and grade of pig-iron. Whilst he (Mr. Rowe) would not care to be dogmatic on these points, he suggested there were one or two features which were fairly certain. The total carbon content of the cast iron used had certainly a distinct bearing on the tendency to draw. Extremes should be avoided. Use of a large percentage of high total-carbon pig-iron, such as some of the Scotch irons or some of the hematites, would certainly lead to trouble in that direction. Some years ago Messrs. Brown had run into a number of serious cases of porosity in gear blanks through using 30 per cent. of a high total carbon, low phosphorus, Scotch iron on heavy work. Similarly, trouble was also encountered if the total carbon was too low—say, under 3.1 per cent. This could be caused by using too large a proportion of steel scrap or a large proportion of one of the low total carbon refined pig irons, of which there were several on the market. If he were asked to state a total carbon content most suitable for gear wheels he should say 3.15 per cent.

The silicon content was also of importance. Here again extremes should be avoided for the general run of work. Naturally, on very heavy work a low silicon content of 1.2 to 1.4 per cent. was necessary to secure the requisite hardness, but for the general run of gear blanks this was too low, and much more satisfactory results as regarded soundness would be obtained by using a silicon content of 1.6 to 1.8 per cent. The phosphorous content, in normal proportions, appeared to have little or no bearing either on soundness or wear. Usually for normal work the phosphorous content was kept to 0.9 per cent. and for very heavy work to 0.7 per cent. Phosphorus affected the shock-resisting properties of cast iron, and for this reason was not allowed to rise above 0.9 per cent. in any class of gear work.

Bronze Gear Wheel Blanks.

One of the most interesting phases of the founding industry as related to gear manufacture, suggested Mr. Rowe, was the making of gear wheel blanks in bronze. The major portion of the bronze used in gear manufacture

was for worm wheels. The worm gear was a method of power transmission which continued to rise in popularity, due to its high efficiency and quietness in running, both at the commencement and end of its life—a life which was extremely long with correct design. Messrs. Brown had devoted a very considerable amount of time and money to research for the development of worm gear, both in respect of materials and of tooth shapes. The best form of worm gear, they had found, consisted of a case-hardened steel worm running with a bronze wheel. A suitable bronze running with a case-hardened steel had a very low co-efficient of friction and consequently the temperature rise and wear were very small. The composition of the bronze, though very important, was by no means a complete guide to its suitability for the duties in this matter. Correct structure was just as essential and more difficult of attainment than correct composition. The correct structure of any wearing metal was that it should consist of crystals of different degrees of hardness. The difference in hardness could be expressed on the Brinell test as about 70 on the soft portion and about 350 on the hard portion. Most bronzes for bearing purposes contained both tin and phosphorus—two hardening elements only fully recognised in recent years. In recent years Messrs. Brown, as result of investigation and experience, had cut down the phosphorus content considerably. Lead was often added to bronze for bearings, but unfortunately this could not be done in making a worm wheel bronze because of its effect in lowering the strength, even though it gave a better co-efficient of friction. Zinc considerably hardened the soft portion of the alloy and lowered the difference between the hard and soft portions, whereas in this class of work the desire was really to preserve that difference as much as possible. One of the main troubles in founding bronze was due to gas inclusions and oxide inclusions. In every case it was very deleterious and the same remedies had to be applied. Most people nowadays were blaming the copper ingots as the source of the gas trouble, as undoubtedly some of the qualities of the copper were sacrificed for a good appearance of the ingot. To ensure success in bronze founding, one must be very careful of the raw materials and the manner in which they were used. The metal must be perfectly clean. Indiscriminate use of scrap metal, bearing dirt owing to its exposure to the elements, would give trouble. Once one had tin oxide in bronze it was practically impossible to eliminate it, and even phosphorus would not ameliorate the trouble. At Messrs. Brown's undertaking nowadays the majority of the worm wheel blanks were cast by the centrifugal process, which the visitors had seen during the afternoon. They still cast the big blanks by the ordinary sand method, but one could not guarantee the homogeneity of a sand casting. The bottom of the pitch of the tooth came in the centre of the worm blank—the worst part of it—and many wheels had to be scrapped owing to porosity. It was impossible to fix a size of runner for every type of wheel made by an undertaking producing such a wide variety of wheels as did Messrs. Brown. The logical step from sand casting was to chill the periphery, but that, whilst giving better results than sand casting, had its special disadvantages. One was that it did not produce the best structure of which the metal was capable, owing to the rate of cooling. From chilling on the outside, they progressed to chilling all over, and that was a distinct improvement over the single ring chill. The rate of cooling was speeded up, but there were considerable difficulties in casting phosphor bronze in a chill. They had to cast at a very high temperature to ensure free running.

Advantages of Centrifugal Casting.

Experiment and experience has shown that by centrifugal casting they produced a structure which was superior to that in any of the other methods. The effects of this method were not yet entirely clear, but there did seem one or two points which were fairly certain. The reason of the small grain was not due solely to the chilling effect. It would seem that the metal was in a constant state of agitation throughout the process of solidifying, and that constant stirring had an effect in giving better grain size. They got a much heavier wheel, the density being 8.9 as against 8.4 by sand casting. Centrifugal castings in some respects were considerably easier to produce than sand castings, because variation in some of the conditions did not make so great a difference to results. Casting temperature was not of so very great importance as in sand casting. They had a wider range of casting temperature and the variation in size of wheels had less influence. A product from centrifugal moulds was within much closer limits as regarded hardness and density than in sand casting. One could be sure that if the products were sound at the rough turning process they were sound throughout, and therefore there were no anxieties as to the later processes.

Case Hardening.

The case hardening of the worms and other gears formed a very important part of the work in turning out such products. One of the worst troubles in case-hardened blanks was the selection of a suitable steel, and unfortunately the steel manufacturers did not seem to have realised yet the full need of the gear trade, although considerable progress had been made in recent years. Apart from defects in bars and billets, one of the most serious troubles was in obtaining a case-hardened steel free from segregation. During the past few years the use of low-carbon case-hardening steel had gradually been discontinued in gear manufacture, as the majority of gears called for strong material, and most of the steel now was an alloy material, generally 3 per cent. nickel. The heat treatment of nickel was surer and more foolproof.

Mr. Rowe proceeded to show pictures illustrating comments on fibrous material, the cause of fibre, grey *versus* crystalline fractures, transverse *versus* tensile tests, troubles in carburising, effects of over carburising, effects of heat treatment on low-carbon steel and 3 per cent nickel material, surface hardening, etc.

DISCUSSION.

Mr. J. S. G. Primrose, opening the discussion, said the lecture was, to all intents and purposes, a continuation of the series of Papers and addresses which had previously been given by Mr. Rowe to the Institute of British Foundrymen. Most of them know well what a keen and painstaking worker Mr. Rowe was, and they had never had more evidence of that fact than in this lecture. The way in which Mr. Rowe seemed able to make the material obey Messrs. Brown's requirements was commendable. An outstanding feature of the lecture, Mr. Primrose thought, was the way it showed what a great and controlling factor was the microscope in all phases of heat treatment of metals. In a recent Paper Mr. Rowe had mentioned that he was carrying out some scientific experiments in regard to wear, and it would be extremely interesting if he were yet in a position to say anything as to how he was determining the wear factors by speeded-up methods in the laboratory instead of having to wait for years to see the effects of wear in ordinary practice. In the iron foundry they were accustomed to cast their metal and practically let it go at that. The steel manufacturer, on the other hand, had to regard casting as only the beginning, and there were many processes to follow. Personally, Mr. Primrose believed the position in iron foundries was gradually coming more on to the latter lines; he thought the time was coming when they would have to do much in the way of oil tempering, etc. Mr. Primrose moved a hearty vote of thanks to Mr. Rowe and to Messrs. Brown for the lecture.

Mr. W. H. Poole (Keighley Laboratories, Limited), seconding the vote of thanks, said Mr. Rowe was to be admired for his courage on the question of the value of fibrous structures for a core of a case-hardened steel. He was rather in the position of a David putting forward views which probably might not meet with general agreement on the part of the Goliaths of the steel industry; yet he (Mr. Poole) believed, as one whose business it was to do a good deal of research, that Mr. Rowe was probably right in his suggestions. It was, of course, a commonly accepted opinion that unless the core fibred well the steel was not of the best type. Whilst this may be so in some cases, he was personally quite in agreement with Mr. Rowe that for gear work, at any rate, an excessively fibrous type of core was unsuitable for the best type of gear wheel. Mr. Rowe took up a view on this subject which probably exposed him to much criticism.

Mr. Kent, referring to Mr. Rowe's assertion that in casting phosphor-bronze rings by the centrifugal method there was not the same necessity for great care as in sand moulds, asked was it possible that the regularity and uniformity of structure in the centrifugal castings was due to some extent to the thickness of chill?

Mr. R. A. Miles asked whether the lecturer made any experiments with the spinning of sand moulds for the cast iron in to increase density of the material in the ring?

Author's Reply.

Mr. Rowe, replying to these and other brief questions raised by members, said some laboratory tests as to wear had been tried, but they had not found, up to the present, that there was any satisfactory quick and royal road to getting at the relative wearing qualities of the materials such as would be yielded by actual service conditions. They had certainly got some very interesting results from several methods of wearing tests, but the only way to reproduce service conditions was to run a gear under such conditions. If they tried to speed up service conditions in a test by overloading, they got an accelerated wear, and they would find that results were liable to be misleading. Actual service test was, of course, a long job, but up to the present it seemed to be the only thoroughly satisfactory test. By laboratory tests, however, they could get the coefficient of friction, and it was found that that was a very good guide to the wearing qualities, coupled with the breakdown of the skin under heavy loading conditions. They had found that the centrifugally-cast bronze was considerably superior to sand-cast bronze in both these respects, and there was very much less variation between one casting and another. In regard to Mr. Poole's comments on the subject of fibrous fractures, it was quite true that there were very few steel manufacturers who seemed prepared to grant this point. Somehow a fibrous fracture did look nicer. He was quite ready to admit that there were some engineering parts in which a fibrous fracture was an advantage, but these cases certainly did not refer to gear blanks with the teeth cut in. Such things as a gudgeon pin or a brooch might find it an advantage to have a fibrous fracture. In regard to a question as to the relative merits of oil-hardened steel and case-hardened steel, he (Mr. Rowe) said he was sure a case-hardened steel would have as good a shock strength as an oil-hardened steel, and it would wear better. With reference to phosphorous oxide in bronze, his firm got rid of all the oxide before they started making for castings. It was essential to melt the copper under such conditions that copper oxide would not form, or was removed. On the question in regard to the difficulties of chill casting for sand castings, Mr. Rowe said it was more difficult where the ring chill was used. The pouring temperatures and the size of the runner had to be controlled very carefully. Mr. Miles had raised a question as to spinning sand moulds for cast iron. He (Mr. Rowe) had not done anything in that way up to the present, but he had hopes of doing so in the future. Where one tried spinning cast iron in sand moulds one had many more complications than with a still mould, but from what he had seen in steel castings there was little doubt that it would add considerably to the density and strength of the material. But not all cast-iron material would stand much increased expenditure, and if one was going in for increased-expenditure cast steel, if he may venture to say so in a meeting mainly of ironfounders, was better!

Mr. S. W. Wise supported the vote of thanks to Mr. Rowe and to Messrs. Brown on behalf of the West Yorkshire foundrymen, and said the methodical way in which the whole of the day's proceedings had been carried out reflected great credit on the firm. He would particularly like to pay a tribute to the selection of the guides for the party.

Systems of Steelmaking Examined.*

On being asked by the Chairman, Mr. W. B. Lake, to open the discussion, Mr. Wesley Lambert (Vice-President of the Institute) asked Mr. Deschamps what was the capacity of the converter mentioned, as figures had been given of the air pressure, etc. Referring to the introduction of aluminium into converter steel, which practice Mr. Deschamps did not consider very desirable, Mr. Lambert asked whether, assuming the steel to have been previously deoxidised by the introduction of ferro-manganese, etc., had it not been found advantageous to introduce also just a small quantity of aluminium, which metal was said to reduce the last traces of oxides that might be present. The addition of aluminium appeared to him to give an increased amount of life to the metal, and it was a general practice in his time to put in a small knob of aluminium. He had no experience of the use of calcium silicide, although some of his colleagues had used it, and he asked Mr. Deschamps what quantity of the calcium carbide was introduced for a given weight of steel. He also asked what was Mr. Deschamps' personal experience with regard to the addition of ferro-titanium to steel, and what type, whether high or low carbon was used.

Referring to the problem of fluidity, the speaker said he had heard many statements made as to the greater fluidity of steel melted in a converter compared with steel melted in an electric furnace. Mr. Deschamps had said that the very best steel for castings was made in the electric furnace, but had admitted that electrically-melted steel was not so fluid, and ascribed the want of fluidity to be due to the presence of occluded oxides. He (Mr. Lambert) could not understand how a steel could be the best steel if it contained occluded oxides and by virtue thereof was admittedly a less fluid steel. If a blown steel were more free from those oxides, and, by virtue of being free from them, was much more fluid, how could one reconcile Mr. Deschamps' statement that the electrically-melted steel was the better steel? That electric steel was better than blown steel had many times been testified by reputable lecturers, until one had perforce to think it must be so. All the same, if Mr. Deschamps' explanation as to the lack of fluidity of electric steel was the correct one, it was difficult to conceive why electric steel was considered the best steel.

Influence of Condition of Sulphur.

With regard to sulphur, he had understood Mr. Deschamps to say that if one had a steel containing as much as 0.07 per cent. of sulphur, provided it was combined with the requisite quantity of manganese, it was a better steel than one containing less sulphur not wholly combined with manganese. He (Mr. Lambert), however, could not agree that there should be anything like 0.07 per cent. of sulphur in good steel. The lower the sulphur content in a steel the better, because his experience had shown that with 0.07 per cent. of sulphur, combined with manganese as manganese sulphide, much of that compound, instead of rising to the top of the molten metal, was disseminated throughout the mass of metal, and had a nasty habit of segregating into very large pools as the metal passed through the transition from liquid to solid. He had seen disastrous results due to these large segregations of manganese-sulphide, and he could not agree that one could rely upon a really good casting from metal with as high a content of sulphur as 0.07 per cent., even if it were wholly combined with manganese. In a good casting steel for large castings the sulphur content should be as low as possible. Finally, Mr. Lambert expressed his personal indebtedness to Mr. Deschamps for his very comprehensive review of the manufacture of steel for castings.

Mr. V. C. Faulkner (Past-President of the Institute), whilst thanking Mr. Deschamps for a very clear exposition of the metallurgy of the manufacture of steel for steel castings, said that unfortunately Mr. Deschamps had made some fundamental mistakes, which required correction. When speaking of the crucible process, for instance, Mr. Deschamps had given the impression that the placing of a lid on the crucible made it gas-tight. He could assure Mr. Deschamps that the crucible offered absolutely no protection whatsoever against furnace gases; that the crucible, as an entity, might as well not exist from that point of view. It was a protection, certainly, against contact with solid carbon, but gases would pass through it as though it did not exist. Another fundamental error which Mr. Deschamps had made, and which was constantly being perpetrated, was the reference to the carbon, manganese, sulphur and phosphorus as "metalloids." There was only one metalloid incorporated in steel and cast iron, and that was silicon—or perhaps two, if titanium were included. Manganese was a metal, and sulphur, phosphorus and carbon were non-metals, and he asked Mr. Deschamps whether the equivalent of the word "metalloid" was used in French metallurgy in a wrong sense as in Great Britain.

The Poumay System.

Referring to Mr. Deschamps' account of the installation of the Poumay system, he asked whether there had been associated with the decrease of melting coke an increase in the ferro-silicon additions, because silicon, even in the cupola, could sometimes be regarded as a fuel, and it would be interesting to know whether economy in carbon was off-set by extra expenditure on another fuel in the form of ferro-silicon.

Soda Ash for Sulphur Reduction.

Dealing with Mr. Deschamps' reference to the addition of alkalies to the molten metal in the ladle for the reduction of sulphur, he said he had been told that sometimes these alkaline additions evolved caustic soda or caustic potash, which, making contact with the moisture on men's hands and faces, caused burns. The burning of the men in this way had actually been experienced in the north of England, and he asked how that had been overcome. With regard to Mr. Deschamps' statement that in the Tropenas process the manganese was oxidised to manganese dioxide, he believed a slight chemical error had crept in there. It appeared that it was manganous oxide, and not manganic oxide, which was formed, and took its place in the usual slag-making equations.

Mr. Deschamps, in his first reference to the electric process, had referred to "amorphous" electrodes. The word "amorphous" had crept into trade nomenclature, however, in order to differentiate from graphite, and Mr. Faulkner asked whether Mr. Deschamps agreed that it was an unsuitable term to apply to the electrodes. Really they were not chemically amorphous electrodes, but were simply aggregations of either coke or anthracite, agglomerated with tar. In dealing with the oxidising process of the basic electric furnace Mr. Deschamps had shown equations for phosphorus reactions, so that the phosphorus existed in the slag as calcium phosphate. He (Mr. Faulkner) did not think that was correct, but that it existed as iron phosphate. There was usually insufficient lime present to convert it to calcium phosphate.

The "Life" of Electric Steel.

Mr. Faulkner insisted that the word "life" was a better word than "fluidity" for foundry practice. Owing to the exceptional quietness of the steel lying in a basic electric furnace, some non-metallic inclusions, such as calcium silicate and the like, became entrained in the metal and never left it, and he thought that that was the real reason for the loss of life in well-made—he used the term advisedly—basic electric-furnace steel, because it was just when the steel was exceptionally well made, and when the sulphur had been brought down to the lowest possible figure, that the absence of life made itself evident. With regard to Mr. Deschamps' comparison of processes, he said that if one would omit the exception of "life" and judge the resultant steel purely upon its tensile and chemical characteristics, one could state almost definitely that the quality depended upon the violence with which the oxidising reactions had taken place. Thus the basic Bessemer was probably the process which required the most drastic treatment and resulted in the worst quality of steel, whereas the electric-furnace process, which was definitely a reducing process at the finish, would yield the very best steel from both the chemical and the tensile strength points of view. Finally, he said he considered Mr. Deschamps' last suggestion of a micro test for steel was rather comical, because by shifting the microscope a mere fraction of an inch one could show either the best possible structure or a very bad structure.

Mr. H. C. Dews, referring to Mr. Lambert's reference to the supposed deoxidising effect of aluminium, said he was not quite sure that it had yet been definitely established that aluminium did deoxidise steel, or any other metal for that matter. It seemed rather far-fetched to imagine that the trace of aluminium that was usually put into a ladle of steel or cast iron was likely to combine with any oxygen that might be in the steel, particularly as one was supposed to have deoxidised the steel beforehand. He considered that the careful study by metallurgists of the action of aluminium and other alleged deoxidisers on metals was overdue, and asked Mr. Deschamps if he would give his views on the effect of aluminium. Finally, he expressed great appreciation of Mr. Deschamps' work on steel.

Light Emissivity and "Life."

Mr. C. H. Kain referred to Mr. Deschamps' statement that one of the great advantages of the basic electric furnace was that one could use high sulphur scrap and produce good steel from it. It was true, he said, that that could be done fairly easily, but it involved the use of a reducing slag on the metal for a long time, and that invariably resulted in a sluggish steel, so sluggish that it was useless for ordinary casting work, especially if it had to be cast from hand shanks. He had had trouble with basic electric steel through sluggishness and lack of fluidity, and frequently a non-fluid steel had been obtained which would almost freeze up in the shank, but if cast direct from the ladle nozzle it would pour the thinnest sections. That seemed to lend support to the theory that lack of fluidity was due to a peculiarity in the steel which gave it a very high power of light emission, and a considerable amount of energy was lost as light. Non-fluid steels were frequently of a blinding white colour, much more binding than that of an ordinary fluid steel. Mr. Kain associated himself with Mr. Faulkner's view that calcium compounds had a distinct effect upon fluidity, because he had found that calcium silicide additions, although they deoxidised the steel, tended to make it sluggish.

If a bath of steel were melted quietly and tapped under a reducing slag it was much less fluid than a bath which had been melted with a fairly high carbon content and violently agitated by the addition of iron ore to reduce the carbon, and quickly finished under a reducing slag. That led to a consideration of the question of speed. Many authorities had assured us that one of the greatest dangers of the iron and steel industry to-day was the craze for speed, and as a result of it we were getting poor pig-iron from the blast furnace, poor steel, and so on. His experience, however, was that most decidedly one of the secrets of making good basic steel for casting purposes was speed. The faster it was made the better, especially after the skimming off of the first slag.

Mr. J. W. Gardom, referring to Mr. Faulkner's criticism of the suggested micro test, pointed out that the usual method of examining anything under a microscope was to use a very low power first.

The Branch-President (Mr. W. B. Lake) said it must not be assumed that a lid on a crucible protected it entirely. He had had a great deal of

* Being a discussion on a Paper entitled "Steelmaking, with Special Reference to the Manufacture of Steel Castings," by Mr. J. Deschamps, which was printed in our last issue.

experience many years ago of the making of steel in crucibles, and had found that directly a coke with a high sulphur content was used the sulphur got into the steel at once, which proved definitely that the pots were completely porous. Referring to the use of aluminium, he said that in those early days he used to melt down nothing but Swedish steel scrap in the crucible, and put nothing else in at all. If it were cast straight out, the castings were, practically without exception, spongy, but when a little aluminium was placed in each crucible perfectly sound castings were produced.

Mr. Faulkner asked what percentage of aluminium was used.

The Branch-President said he did not know exactly—it was supposed to be a secret process in those days—but it was a small piece, about the size of half-a-crown. That was direct proof that aluminium did de-oxidise steel.

The Triplex Process.

With regard to the Triplex process, he said he had seen it in operation only once, at the National Malleable Company's works at Cleveland, and there it was working without a hitch. They were making malleable iron from metal which was melted in the cupola and de-sulphurised in the ladle; half of it, he believed—though he was not quite certain of the proportion—was transferred directly to an electric furnace, and the remainder went into a converter and was blown before transfer into the electric furnace. That operation was being carried on with the greatest regularity, and he could not see why it could not be carried on the same way in this country if we wanted to do it; he did not think anyone wanted to do it. Continuing, he said that Mr. Faulkner appeared to have contradicted himself in the course of his remarks. In the first place he had suggested that basic steel—which was "dead killed"—owed its sluggishness to non-metallic inclusions, and then had said that this steel would give tensile tests superior to those of practically any other steel. It seemed to him (the Branch-President) that those two statements could not be reconciled. He maintained that if there were enough metallic inclusions in a steel to make any real difference to it they must reduce its physical tests. Finally, the Branch-President expressed appreciation of Mr. Deschamps' Paper.

Vote of Thanks to Mr. Deschamps.

Mr. H. G. Sommerfield (Hon. Secretary) proposed a vote of thanks to Mr. Deschamps, and assured him that the members were grateful to him for having read such a delightful Paper. He also recalled that at the time of the Institute's Convention in 1926, in London, the members had been invited to see Mr. Deschamps' works at Letchworth. They had been glad to accept the invitation, and were entertained by Mr. Deschamps and Mr. Jacks, the works superintendent, to a really instructive tour of the works.

Mr. Sommerfield also extended a welcome to an old friend, Mr. Morten Grindal, of Bergen, Norway, who had been associated for many years with the only malleable works in Norway. This was Mr. Grindal's first visit to any Branch of the Institute, and he hoped Mr. Grindal would take back to Norway with him an expression of the good feelings which British foundrymen entertained for their confrères across the seas.

Mr. A. W. G. Bagshawe, seconding the vote of thanks to Mr. Deschamps, said the members very much appreciated the Paper he had read. Mr. Bagshawe added that he was very much impressed by the fact that there was such a large attendance at that meeting, having in view the fact that the subject discussed was one which many of them did not fully understand. That showed that foundrymen were now willing to learn something about jobs other than those upon which they had to spend the greater part of their time. There had been a tendency among iron-founders to concern themselves only with the process, or perhaps the particular type of castings, they themselves were making, and not to take very much interest in others. The fact that the attendance that evening had been so large was one of the most encouraging things in his experience as a member of the Institute.

The vote of thanks to Mr. Deschamps was accorded with acclamation.

Author's Reply.

Mr. Deschamps, after responding to the vote of thanks, replied to the discussion. Dealing with Mr. Lambert's questions, he said the capacity of the converters at Letchworth was approximately 1½ tons—from 30 to 32 cwts. With regard to the suggestion that the addition of a small quantity of aluminium was advisable, he said that in practice he was using it for the sake of the old timers. He did not think it was right, but he had cut down the quantity used, and now allowed the men to use only a quarter of the quantity previously added. The reference of Mr. Lambert to calcium carbide was a mistake; he had said calcium silicide. The calcium silicide had replaced the aluminium, and had given considerably better results—not only a better de-oxidised metal, but a cleaner metal generally. He had ventured the explanation in the Paper that the calicum element might form, with existing silicates of iron and manganese, a multiple silicate, which was bound to be more fusible than a simple silicate. With regard to ferro-titanium, he said he had used it because he thought it theoretically right to do so, especially in a pneumatic process like the Bessemer, where one passed a considerable amount of air over the metal. Supposing the oxygen of the air were combined with silicon, manganese and carbon, there was four times as much nitrogen in the air as oxygen, and it must have a tendency to remain occluded or dissolved in the metal. Titanium was supposed to combine with that nitrogen, but he did not believe it did, because he had never found an improvement in the physical properties as the result of its use. Moreover, it was an expensive alloy, it had a very high melting point, and, although American foundrymen believed in it very much, his results had been negative.

Ferro-titanium with high carbon was more difficult to melt than that which was carbon-free. It might be asked what happened to the nitrogen if one did not use ferro-titanium, for there was nothing else but the ferro-titanium with which the nitrogen might combine. His view was that the nitrogen remained dissolved in the metal. He had heard the opinion expressed that ferro-silicon acted not only as a de-gasifier—it acted in reducing the carbon monoxide by combining with the oxygen of the carbon monoxide to make silica—but also had the property of increasing the power of the metal to hold nitrogen in solution. As to fluidity, Mr. Lambert did not understand why it was that a converter steel was better from the steel founder's point of view than an electric steel, inasmuch as it was less pure chemically. This melting shop was staffed not with pure scientists, but practical men who had to make satisfactory castings from steel, and the point was that so long as those castings would meet, and more than meet, the specifications imposed by the user upon the steel maker, why make them so much better than was required? Basic electric steel might be extremely pure, with only traces of sulphur and phosphorus, but he saw no reason why a steel which was more fluid, and would feed the casting better, should not be used, provided it was up to specification. He had had experience on many occasions of castings made with converter steel (of the same temperature as that supposed to have been attained by the basic electric steel), which had been perfectly sound, although the steel was much less pure chemically than the electric steel. From the metallurgical point of view, the basic electric steel was superior to the converter steel, but he knew very well that the foreman moulder preferred to cast a given mould—unless it was extremely intricate and there was a tendency to cracking—with converter steel rather than with electric steel, because he could feed the casting better. It should be mentioned that one could always get fluidity provided a sufficiently high temperature was attained, up to a point. For instance, an electric steel at 1,685 or 1,700 deg. C. would probably be more fluid than a converter steel at 1,620 deg. C.

The Branch-President added that once one obtained a steel "dead killed," one could continue to heat it, but could not improve its fluidity; it appeared to get worse.

Mr. Deschamps said that seemed to point to the explanation that fluidity was due to the presence of non-metallic inclusions, so that one came to the conclusion that it was better for the person who had to produce a sound steel casting to have a fluid steel rather than a too pure steel. With regard to Mr. Lambert's point that a steel containing 0.07 per cent. of sulphur, even if that sulphur were combined with manganese, could not be so good as steel with a lower sulphur content, because of the segregation of manganese sulphide in large pools, Mr. Deschamps said he did not think there would be considerable amounts of manganese sulphide unless the sulphur content was greater than 0.07 per cent.

Mr. Lambert said he was speaking of castings from which the head had been cut off, a slab cut from the head, and a test bar cut from that. Very large pools of manganese sulphide had often been found in the heavy sections.

Mr. Deschamps replied that in his experience microscopic examination—a really honest examination—of steel containing 0.07 per cent. of sulphur, when combined with manganese, showed that MnS was fairly uniformly distributed in small globules, the area of a section of each globule being something like one-third of the area occupied by individual crystals of pearlite in well-annealed steel.

Mr. Lambert said he was speaking of pools of ⅜-in. long and about 1-10 in. in diameter. They were quite considerable.

Mr. Deschamps said he had never come across that. Replying to Mr. Faulkner, he confessed that it was probable that he had been talking through his hat when he had referred to the crucible furnace. He had never worked with a crucible furnace, but if a lid were of no use whatsoever, why was it used at all?

Mr. Faulkner said its purpose was to prevent coke dropping in.

Mr. Deschamps suggested that that did not matter much, because one put coke in, or charcoal, anyhow. The Branch-President had said that the sulphur got through the crucible.

The Poumay System.

Mr. Deschamps agreed that the term "metalloid" was a misnomer when applied to manganese. With regard to the Poumay cupola, he said he had not experienced loss of silicon. Not only was it unnecessary to use more silicon in the cupola than previously, but he had found also that there was a considerable reduction of the ferrous oxides in the slag. That seemed to prove that the atmosphere of the melting zone in the Poumay cupola was more reducing, or rather, less oxidising, than that in an ordinary cupola, which was in agreement with theory, since less air and less oxygen was admitted. Probably the gas passing through the melting zone consisted of half CO_2 and half CO, whereas in an ordinary cupola probably 95 per cent was CO_2, and 5 per cent. CO. He had received a few complaints with regard to the noxious fumes resulting from the use of alkalies, but he did not think they were very serious. Every time he had tried to test it, to the extent of putting his face into the fumes, although it was not particularly pleasant, he had not felt much the worse for it. There was a tingling effect on the skin. The men did not like the process. It was not very pleasant to remove slag from the top of a ladle by means of a long wooden tool; also, it was hard work, and if the men could find an excuse to avoid it they would do so. He agreed with Mr. Faulkner that he had made a mistake in his reference to the Tropenas process, and that the manganese was oxidised to MnO. He agreed also that the expression "amorphous electrodes" was a misnomer. They were not really amorphous, but an aggregate—sort of concrete. The suggestion that in the basic electric process the phosphorus did not exist in the slag as calcium phosphate, but as iron phosphate, he disagreed with, because there was an obvious excess of lime. He thought he

had made it clear that a considerable excess of lime—more than the amount required for de-sulphurising and even more than that required to satisfy the chemical reaction of fixing the phosphorus as a phosphate—was present in the slag. He would not express too definite an opinion, however, as to whether it was iron or calcium phosphate. In his remarks dealing with the effect of sulphur, he had referred to steel in the annealed condition. In etched sections under the microscope one could see chain-like inclusions surrounding the grains, and bad physical properties could always be associated with these inclusions, which might exist to a considerable extent in steel having 0.04 per cent. sulphur, but would be totally absent in steel having 0.07 per cent. sulphur if that sulphur were combined with manganese. Discussing Mr. Faulkner's somewhat caustic comment on the suggested micro test, he said some people did not know what a microscope was, but his idea was to insist upon inspectors being conversant with the microscope, and that they would move the sample about under the microscope and find out all there was to find out.

Aluminium as an Impurity in Steel.

Replying to Mr. Dews' query as to whether aluminium did or did not de-oxidise metal, he said his experience was more or less the same as that of the Branch-President, namely, that it did de-oxidise, but he maintained that it was very harmful, especially in very mild steel, owing to the product of de-oxidation—viz., alumina. Quoting an example of this, he said that some time ago a customer had complained that when machining magnet cases he had found some very hard spots. With the converter process one could make magnet steel with a very high magnetic permeability, because it was practically pure iron. The cases complained of had a carbon content of 0.07 per cent., and something like 0.03 per cent. of manganese, and there was no reason for the presence of hard spots in more or less pure iron. He had had a piece cut out of the castings complained of, however, and a microscopic examination had revealed particles of Al_2O_3, which were the cause of the trouble. In magnet steel he used aluminium; one could not use ferro-silicon or ferro-manganese very much, because the silicon or the manganese would deteriorate the permeability of the metal. If aluminium were used, and hard spots were present in the metal, it proved that the aluminium had played its rôle and had de-oxidised the metal.

He had heard the suggestion, referred to by Mr. Kain, that fluidity was lost through the emission of light, and considered it ingenious; in fact, it was a little too ingenious, and he did not think it was right. There was a remedy, however, and that was to cover the steel to prevent loss of sensible heat due to radiation. He agreed that speed was essential to produce steel which was good chemically, in the electric furnace, though he did not think it was essential in order to produce steel which would pour easily. It would be much cheaper, however, because the cost of basic electric steel was considerably in excess of acid electric steel, because of the quantity of electric current used.

A New Scandinavian Foundry Equipment Firm.

Mr. Morton Grindal, who returned to his home at Bergen last Thursday after an extended business trip to this country, has been appointed representative in Norway for Messrs. T. H. Gray & Company, Limited (Silacene) and the Fordath Engineering Works Company (Glyso). Mr. Grindal, who has for many years been manager of a malleable foundry, has now started in business as a foundry equipment manufacturer. Last year he visited the Detroit Conference in company with the British delegates.

WORK HAS BEEN RESUMED at the Mossend Steel Works, belonging to Wm. Beardmore & Company, Limited.

Aluminium Bronze.

A meeting of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen was held on Thursday, November 3, at the Engineers' Club, Waterloo Street, Birmingham, when Dr. R. C. Reader contributed a paper, illustrated by lantern slides, on Aluminium Bronze. Mr. F. G. Starr (Branch-President) was in the chair.

Dr. Reader dealt briefly with the general properties of Aluminium Bronze, mentioning that it had a tensile strength of 30-35 tons per sq. in., a yield point of 11 to 12 tons, and an elongation of 25 per cent., which properties, together with its ability to stand up to alternating stresses, made it a very suitable alloy for engineering purposes. Further useful properties included a pleasant yellow colour, resembling gold, which made it suitable for the manufacture of cheap jewellery. It also had a good resistance to corrosion by sea water, so that it could be used for making ships' fittings. The alloy, he said, should not be allowed to cool slowly from the molten state to normal temperatures or it would tend to become brittle. This might happen in the case of large sand castings unless precautions were taken to ensure a quicker rate of cooling, such as removing the castings from the moulds as soon as they had set and allowing them to cool in the air. The mechanical properties of the alloy could be raised by the addition of 2 to 3 per cent. of iron, 5 to 7 per cent. of nickel, or 1 per cent. of manganese, when tensile strengths of about 40 tons per sq. in. would be obtained. Such elements as tin, silicon and phosphorus should not be added, as they lowered the properties, particularly the ductility. The best way of using aluminium bronze to advantage was by die casting it, since it was the best high-copper alloy for the purpose. For die casting purposes it did not possess any of the drawbacks of the brasses. These latter alloys covered the metal mould surfaces with a layer of white zinc oxide, which had to be brushed off after practically each cast, or a good definition was not obtained. Also the brasses were liable to crack in a metal mould, due to being weak at high temperatures. Aluminium bronze was an alloy which readily lent itself to improvement by heat treatment. There were two types of heat treatment which improved castings in this alloy: (1) Quench in water from 900 deg. C., followed by an anneal at 700 deg. C., and cool in the air; (2) heat to 900 deg. C., slowly cool to 600 deg. C., and quench in water. The first type of heat treatment was the one recommended for those castings which might have become brittle, due to slow cooling, and by which the normal properties of the alloy were restored.

Aluminium Bronze Golf Clubs.

MR. D. WILKINSON said he had only had one experience with aluminium bronze, and that was many years ago, when some brilliant person brought out a golf club designed to effect a wonderful reduction in the user's handicap. It was his duty to make 500 of the aluminium bronze shoes for the clubs. Five or six of the first lot of castings were brittle, and he assumed that the mixing had not been thorough. They were remelted and cast again. This time there was no fault to be found with them. It was pretty evident that a little disturbance of the proportions was quite sufficient to cause brittleness. "I fitted one to a club of mine," Mr. Wilkinson added, "but it certainly did not reduce my handicap." (Laughter.) Mr. Wilkinson mentioned that he had seen exceedingly good die castings made with aluminium bronze. He gathered from Dr. Reader's remarks that it was an alloy calling for very careful handling if its best properties were to be secured. He wondered whether die casting with this material would ever become a serious competitor of hot brass stampings. The cost would be more, but there appeared to be the possibility of savings which might more than offset that cost.

Replying to a member who asked if, casting at a low temperature, there would be trouble with pin holes, Dr. Reader said the important point was the original temperature up to which the metal was taken before casting. If they overheated it in the pot before casting they would experience such trouble. If they did not get the copper too hot before adding the aluminium he did not think there would be any difficulty.

Answering another question as to the admixture of iron, Dr. Reader said pure iron should be used, not cast iron; otherwise trouble was experienced from the silicon present. Wrought iron nails were suitable, or even mild steel nails. On the point raised by Mr. Wilkinson with reference to not getting satisfactory castings from the first melt, Dr. Reader mentioned that in the United States he found a division of opinion on the subject. Quite a number of firms made the aluminium bronze first of all into pig and then produced the castings from that. The majority, however, probably cast direct. Provided there was thorough stirring the result was as good as if pig was prepared first.

Asked what was the best casting temperature, Dr. Reader replied: "About 1,090 C. for sand casting, and anything you like for die castng." Everything depended upon the cross section area of a die casting, he added. Probably about 1,200 C. would be a satisfactory temperature. He had seen quite successful die castings done at 1,300 C. If it was a thick cross section area there was no need to cast hot.

MR. T. H. TURNER expressed surprise that an alloy which could give a tensile strength of 40 tons was not better known, and said he thought Dr. Reader was on a very good line. Corrosion resistance and tensile strength were qualities that were wanted.

Dealing with the melting point of the alloy, Dr. Reader said aluminium bronze did not begin to get liquid until it melted, as some of the tin bronzes did. There was no low melting point constituent present. It did not go gradually; when it began to melt the whole lot went.

Dr. Reader was heartily thanked for his paper, and regret was expressed that the attendance was not larger.

New Companies.

Thermostatics, Limited.—Capital £100 in £1 shares, to acquire patents, etc., from F. W. Miller and F. Miller. Directors: F. W. Miller and F. Miller, both of Hazeldell, Aylesbury Road, Hockley Heath.

Harvey Brothers, Limited.—Capital £3,000 in £1 shares, to acquire business carried on at Albion Works, Dukinfield, Ches., by H. Harvey, junr., and G. A. Harvey, trading as Harvey Brothers. Ironfounders, etc.

The Haslam Foundry and Engineering Company (1927), Limited.—Capital £175,000 in 125,000 7½ per cent. cumulative preference shares of £1 each, and 100,000 ordinary shares of 1s. each, to adopt agreement with H. B. Potter and J. H. Lord. Directors: J. H. Lord, Beechwood, Rochdale; H. B. Potter, Lee Cottage, Shawclough, Rochdale; W. G. Haslam, Duffield Road, Derby; W. R. Sharp, 11, Waterloo Place, S.W.1; and H. Clayton, Wayside, Cheam. J. H. Lord chairman for five years.

Obituary.

MR. J. E. SIMPSON, of Frodingham Road, Scunthorpe, manager of the Trent Iron Works, died suddenly in London on November 9, at the age of 61.

MR. FRANK WORKMAN, one of the defendants in the Workman Clark case now being heard at Belfast, died there on November 4. In 1879, with Sir (then Mr.) George Clark, he founded the shipbuilding firm of Workman, Clark & Company, and continued a director until 1921, when on its reorganisation he resigned.

MR. DAVID WILLIAMS, publisher and sole owner of our American contemporary, "The Iron Age," from 1868 to 1909, has died at the age of 85 years. He was born in Waterford, Ireland, and went with his parents to the United States in 1850. His father, John Williams, in 1855 began the publication at Middletown of the trade journal known as the "Hardware Man's Newspaper." The journal first appeared under its present name, "The Iron Age," in April, 1859. David Williams acquired "The Iron Age" from his father in 1868. In 1909, after 41 years of ownership and nearly a half century of connection with "The Iron Age," Mr. Williams disposed of his publishing business to a group of men in New York trade journalism, headed by Charles T. Root.

Steel Foundry Practice.*

By A. D. Kirby.

Sands Employed.

It is proposed to deal with this subject in three parts, namely, sands used, method of moulding, and manufacture of steel.

Various kinds of sands are used both for moulding and coremaking. Previous to the outbreak of the war a large number of the steel foundries of this country relied to a large extent upon Continental sands, but circumstances compelled us to overcome the stoppage of supplies from abroad. Being thrown upon domestic resources, these were developed, and steel foundry sands are now prepared in our own country equal, if not superior, to any Continental sands. A steel foundry sand must be highly refractory to withstand the enormous heat of the molten steel. A sand fairly high in silica, with sufficient alumina and iron oxide to give the necessary bond and as free as possible from lime and alkalies, is required to give the desired results.

Naturally the strength of the sand must be varied to meet the requirements of the different types of castings which are made in a steel foundry. Mild steel castings are liable to pull, consequently the facing sand used for these castings must be strong enough to hold up to the steel during casting, but the mould must be weak enough to give way as soon as the job is cast, otherwise unsightly pulls or tears will occur on the casting. In some cases the mould face is reinforced by the application of a paint made from silica flour. Applying a paint to the mould face certainly helps to make the casting strip better from the sand, but the author has his doubts as to whether it is always beneficial.

It is desirable to save fettling costs wherever possible, but it does not always follow that a casting which has left the mould nice and clean is a good, sound casting, although no defects are discernible. Some castings, apparently perfect when leaving the foundry, turn out defective when they have been machined, due, maybe, to the injudicious use of paint. On the other hand castings made without the application of the paint (although rough-looking compared to those that are painted, due to the sand burning on in places) have machined perfectly.

Oil Sand Cores for Steel Casting.

For very heavy castings, compos are used made up from old crucible furnace pots, best clay, firebricks, and powdered coke. Most firms catering for heavy steel castings prepare their own compos, but in the case of foundries requiring these compos only occasionally, or in small quantities, they can be supplied by merchants. Of recent years oil sand for coremaking has become the vogue to a great extent. Whilst agreeing that excellent results have been attained with oil-sand cores, probably there is a limit to their usefulness. In foundries that are mainly concerned with repetition work, such as motor works, it is conceivable that they can be used with advantage, but for jobbing shops they are not an economical proposition. It has been said that oil-sand cores can be produced cheaper than other cores. That may be so far as labour costs in the core shop are concerned, but one point that must be kept in mind is that the sand cost for oil sand is far larger than for the ordinary core sands.

In preparing the different facing sands great care should be taken to attain the correct moisture both for green sand and dry sand work. This remark applies equally as much to the floor sand. Some moulders consider that if a mould has to be dried in the stove, it does not matter if the sand they are using is too damp, but although it does not cause as much trouble as it would in a green sand mould, it is bad practice and liable to cause trouble. In green-sand moulding it is essential that both facing sand and floor sand be kept as dry as possible. After being once used the facing sand is only used afterwards as floor sand, except for certain classes of work, when a certain proportion of it can be mixed up with the new sand, but this is only advisable in rare cases.

Moulding Boxes.

Seeing that a number of steel castings require large feeder heads, it is not advisable to have the boxes made with the bars cast in, except in special instances and also in the smaller sized boxes. In a foundry where only a limited space is available for box plant this is an important point.

In the foundry with which the author is associated this type is in regular use. The inside sizes are 3 ft. sq., 3 ft. 9 in. sq., 4 ft. 6 in. sq., 5 ft. 3 in. sq., and 6 ft. sq. Above the largest size they are built up in sections. Internal lugs are cast within an inch of the full depth of the box and cast steel bars can be wedged in to suit the job. For the two largest sized boxes holes are cast in instead of internal lugs, and the bars bolted to the box. The depth of the box is one foot for the three smaller sizes and 1 ft. 3 in. for the other two sizes. A box and plate is used for the bottom half of the mould and the top part has bars put in where required. The internal lugs being practically the full depth of the box enables the moulder to lower the bars to any depth required. The bars used are about 4 ft. deep, so that if the job being made requires a flat top-part he lowers the bars and rams up only 5 or 6 in. of sand. Many jobs have to be cast vertically, and it will be observed that the box has an open end to allow for this. The plate can be unbolted, and the runner and feeder head cut through the open end. After being closed and bolted together the whole job is turned upright.

The above type of box is very useful for a jobbing foundry, and the same principle can be adopted in the case of round boxes. When making a mould care should always be taken to ensure the correct location of the runner and feeder heads, and measures taken to eliminate, as far as possible, any contraction pulls. As a general rule a steel casting should be run at the lowest point, and at the thinnest section if possible.

Runner Details.

The location and shape of the in-gate is one of the most important points in steel founding, and experience has shown that more wasters are attributable to improper gating and running than to any other cause. The area of the in-gate should gradually diminish from where it leaves the down-runner up to its entry into the casting, and both down runner and in-gate be as small as possible, consistent with safety. When casting a job it is essential that the runner bush be filled up as soon as possible and kept up to avoid any scum entering the mould, also preventing air being taken in along with the steel and getting trapped close to the runner. Castings have been noted where the knocked off in-gate shows in some cases distinct drawholes, and in other cases blowholes at that particular point. The holes are undoubtedly caused by improper gating; the area of the in-gate being larger than the section of the casting at that particular point causes the in-gate to solidify later than the casting, the result being that the casting at that point is robbed of a certain amount of metal which is transferred to the in-gate. In no instance should the area of the in-gate be as large as the area of the casting. If a blowhole is discernible at this particular point the author can give no other reason for its appearance other than it being due to the runner bush not being kept filled up during casting, and consequently air being trapped at a vital moment. It seems logical that if the in-gate is placed as low as possible, and the runner bush filled up as soon as possible, the inflowing and uprising steel will drive all mould gases before it, and they can escape through the exits provided. If too large a runner is used it is impossible to fill up the runner bush soon enough and the mould is filled far too quickly to allow the mould gases time to escape. Hence the benefit of small runners and elimination of blowholes. When debating this point one is at times confronted with the query as to what will happen if one receives a cold heat. That should not often happen, and if such an occasion does occur surely the most suitable jobs for casting can be selected. Even if the steel is useless for any job it is far cheaper to put it on the floor than to be continually having trouble with blown castings.

Feeder heads are a necessary evil in the steel foundry. In some cases as much as 100 to 150 per cent. of extra steel in the form of feeder heads is required to ensure a sound casting. When a casting is run from the bottom naturally the steel is beginning to cool by the time it has reached the top of the feeder heads, and in some cases quickly sets on the top. To get full value from the feeder heads when this occurs, it is advisable to apply a small amount of charcoal, otherwise the crust formed on the top of the feeder head quickly spreads and the object of the feeder head is defeated. The value of feeder heads is reflected in the finished casting, and although the size and number should not be exceeded owing to the high cost of the steel and the expense incurred in removing them from the casting, it is false economy to err in the opposite direction.

Wheel Blanks.

Perhaps one of the worst types of casting to make definitely sound is a wheel blank, owing to the tendency for draws to develop at the juncture of the arms and rim. A hard and fast rule cannot be laid down as to the correct method of casting wheel blanks. Every wheel should be treated on its merits. Whereas some can be cast quite safely in a vertical position with one head on the rim, others must be cast horizontally with a head against every arm and a head on the boss, yet again a sound casting can be attained by casting at an angle of from 30 to 40 deg. with one head to feed the rim and one to feed the boss. In the case of a wheel blank with H section arms the draws can often be eliminated by the simple expedient of joining all the arm cores together in the vertical portion of the arm just at the juncture of the arm and rim, thereby forming a hole through every arm at that particular point.

Some castings are so designed that it is impossible to place a feeder head to ensure soundness. When such occasions arise chilling must be resorted to. In the case of an internal boss a specially tinned spike can be inserted in the centre of the boss. External chills can be used in some cases, but wherever possible the internal chill is to be preferred. To overcome contraction pulls, which is the bugbear of a steel foundryman's life, several things have to be carefully controlled.

Making of an Ordinary Tee Pipe.

During moulding of this type of casting, shown in Fig. 1, care should be taken to keep the mould as weak as possible in between the flanges. Making sure that the face of the pattern is rammed firm enough and entirely covered with a minimum amount of facing sand, the moulder should ram the remaining space with a mixture of floor sand and sawdust. In addition after a sufficient amount of facing sand and sawdust sand has been rammed up in the bottom box it is advisable to lay a course of ashes to facilitate the passage of gases generated during casting. When ramming up the top part as few lifters as possible should be used, and the down runner and feeder heads kept clear of the bars so that the job can be quickly eased after casting, and knocked out of the box. When finishing the mould a good fillet should be made at the juncture of the barrel and flanges, and the necessary brackets inserted. At no part of a steel mould should a sharp corner be left. Where the runner and the feeder heads adjoin the casting a fillet should also be applied. Steel will not lay on a sharp corner, and if

* A Paper read before the Newcastle Section of the Institute of British Foundrymen, Mr. Victor Stobie presiding. The author is connected with Messrs. Cook & Co., Ltd., Washington.

the mould is left sharp at any part small pin holes are almost sure to appear at that particular place. When applying brackets to the mould the moulder should be just as careful to take the sharp corner off them as well. Brackets are put on this job for a specific purpose causing a local chill, thereby holding flanges and barrel together during the contraction period. If brackets are not used it is quite easy to imagine what would happen. The barrel portion being of a thinner section than the flanges would solidify first and contraction take place, thereby causing a pull in the neck of the casting. Even if brackets are applied a pull will still take place if the mould is too hard, and by ramming up sawdust-sand where required this is obviated. During the drying of the mould the sawdust is partially burnt out, hence weakening the mould, and giving assistance to the casting during contraction. It is a very common practice to saw brackets in a mould

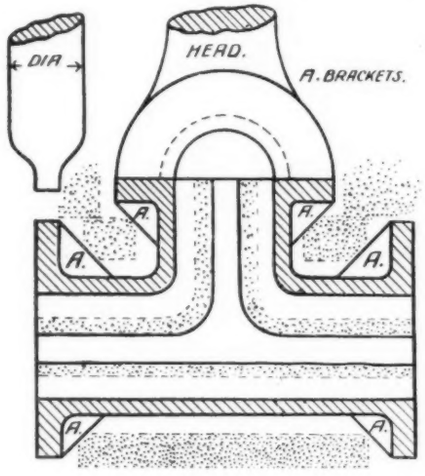


FIG. 1.

after the mould has been dried. Although a quick method this is to be deplored, as it does not make a satisfactory job, the tendency being for the sand to run and grains of sand accumulate in the flanges and in some cases so weakening the mould that pieces of the mould are washed away by the steel during casting. Although taking a little longer to do it is far better practice to make the brackets during moulding, either by ramming them up or else cutting them in the job. The core for a casting of this description should also be as weak as possible, otherwise the barrel portion of the pipe will show an unsightly tear or burst. Wherever possible it is advisable to use loose irons for the core, but when the pipe is of such a size that a grid is required, particular care should be taken that the grid is made small enough so that it can in no way interfere with the casting during contraction.

A fair amount of work can be made green sand or skin dried in the steel foundry, but one must be continually on the alert to control the sand at the correct moisture content and strength or trouble will arise. Colliery castings, such as manganese tub wheels, cast-steel sheaves, rollers, drums, buffer housings, are made in green sand. The rollers average about $\frac{5}{16}$ in. section on the barrel, whilst the drums are $\frac{1}{4}$ in. to $\frac{3}{16}$ in. section.

Vent Wire in the Steel Foundry.

It has often been said that it is not particularly important to use the vent wire in every case, on the ground that a steel-foundry sand is of a very open nature. Whilst agreeing that the sand is altogether of a different nature from that used in an iron foundry, but personal experience has been that wherever it is possible to facilitate the egress of the gases formed from the mould better results are attained. In addition to venting the mould, whistlers should be inserted in any places where there is a likelihood of any gases being trapped. These should be made with a cleaner, and not with the vent wire. The cleaner being broad but thin gives ample space for the gases to escape, but if the vent wire is used there is a tendency for the steel to be forced up the hole made by the vent wire before the job is actually cast, consequently the steel drops back from the hole drawing air along with it which is shown on the casting when the whistler is knocked off. When the cleaner is used the space is only wide enough to allow the steel to follow the gases and when the steel enters the space it quickly sets. The vent wire is insufficiently appreciated, and the moulder should look upon it as his best friend, and the water pot as his worst enemy. As an instance of the utility of venting and applying whistlers, buffer housings initially caused some considerable trouble owing to miss runs. Well venting the top part and placing a row of whistlers right round the top of the job soon eliminated it, and although the author has made several hundreds of them, he is in a position to assert that the percentage of miss-run castings does not exceed 1 per cent.

Steel founders are continually being called upon to produce castings of very thin section. The buffer housings just referred to are an instance, another example is a nozzle segment. The section of steel midway through the core is between 2 and 3 millimetres. The casting is useless if any of the holes inter-marry, and although the casting does not appear exceptionally intricate great care has to be taken to keep the cores in the correct position, and a good hot steel used to ensure a sound casting.

In a very thin-sectioned casting, the overall length of which is roughly 4 ft. and the oblong base is 4 ft. × 2 ft. 4 in., the bosses were 2 in. dia. and the shell only $\frac{3}{8}$-in. section. The specification for this casting was 26 tons tensile, so the difficulty in avoiding pulls and getting the casting to run up sharp is palpable. The core for the base was merely a shell of only 3 in. of sand all round. This involved the use of a grid, but it was made as light as possible. The pattern was faced with no more than 1 in. of facing sand, and the rest of the mould rammed up with sawdust sand. Very hot steel was used, and within two minutes of the job being cast the casting was knocked out of the mould. All concerned were anticipating trouble, but the only defect was a slight pull in the top corner about $1\frac{1}{2}$ in. in length, which was soon remedied. This is a typical case where it is impossible to place feeder heads. To ensure soundness in the bosses chilling must be resorted to, therefore a $\frac{3}{8}$-in. dia. spike was inserted in the centre of each boss to ensure solidification. These spikes are not detrimental to the drilling of the casting, providing they are placed centrally, whilst the dia. of the spike should always be $\frac{1}{8}$- to $\frac{3}{8}$-in. less than the dia. of the bore required in the casting, so that all the spike can be removed from the finished casting.

In the making of a machine-moulded gear wheel in halves, the general practice in iron foundries is thought to be to make one half of the wheel at a time. Owing to differences of contraction in steel, due to several causes, it is advisable to cast the two halves of the wheel at the same time. The method adopted is to place two strong square bars upon the table running parallel with each other. Two rollers are then placed upon the bars at right-angles to them, and two more bars are then placed upon the rollers directly in a line with the bottom bars. The rollers are then wedged with hard wood wedges. The moulding plate and box are then placed on the bars and rollers and one half of the wheel is swept up in the usual way. The centre line is then made on the joint, the wedges removed, and the box is easily rolled the required distance. Generally a 2-in. splitting core is used, so the box is rolled 2 in. This is determined by placing the gauge lath on the centre line and making sure that the box has been rolled the correct distance. This being ascertained, the wedges are again inserted, the other half is swept up, and another centre line made on the joint, which gives a 2-in. oval mould. The tooth block is now placed in the correct position and the teeth are rammed up in this half of the mould. The wedges are again taken out and the box rolled back to its original position, the wedges again inserted, and the teeth rammed up in the other half of the mould. Lines are made on the bottom of the mould corresponding with the centre lines on the joint, this locating exactly the position of the splitting core. The splitting core can have about four holes through, roughly $1\frac{1}{4}$ in. dia. to connect the two halves together. These can easily be broken and removed after the casting is fettled. The advantages of making a wheel by the above method are manifold, moulding costs are lessened, the analysis is exactly the same for both halves of the wheel, and the contraction of both halves is equal. The latter is a very important point, as considerable trouble is experienced when assembling the wheel if there is any variation in sizes of the two halves.

For a brake drum in halves the same principle of moulding is adopted. The only difference being that this job is made on the floor instead of the machine, no teeth being required.

Methods of Strickle Work.

The usual practice followed in steel foundries for strickle work is to have a striking board made that will sweep up both the bottom and top halves of the mould, assembling the mould in the correct position when closing by means of male and female joints, or alternately by cutting guides on the joint of both halves of the mould equidistant from the spindle. Some foundrymen prefer a striking board, so made, that a false bottom part is first swept up and the top half of the mould rammed up from the false part. After removing the top part the sand in the bottom half of the mould is then taken out and another board used to sweep up the bottom half of the mould. Personally, the author prefers the former method, as it obviously saves in both man hours and facing sand. When making castings similar to the brake drum, mentioned above, all in one piece, trouble is often encountered owing to the fact that the job, as cast, assumes a more or less oval shape instead of conforming to a incular diameter. A theory for this happening is that the temperature of the steel plays an important part. Naturally that portion of the casting in close proximity to the runner must receive hotter metal than any other part, being the last served, consequently freezing takes place at this point later than at any other part of the casting. It is only logical, therefore, that at the furthermost point from the runner contraction takes place first and, to use a sporting phrase, "gets so much start from any other part of the casting and the portion adjacent to the runner gets left at the post." The result can easily be visualised. The larger the diameter or the thinner the section of the casting, the greater the distortion of the casting. A foundryman, who favoured the second method of sweeping up a job as against the author, preferring the first method, once said in all seriousness, that the fact that he was sweeping up moulds in the method described was the reason for some castings turning out oval. The assumption was, that the mould would be oval when swept up, but this is impossible if the spindle and sweeping board are securely fixed. Failing this, it is agreed that the mould could be swept up out of shape, but in the event of this occurring it surely applies to both methods of sweeping up the jobs.

The test for anchors weighing over 25 cwts. is as follows. A 6-in. steel plate is placed upon a concrete bed which is 6 ft. deep and the anchor is hoisted 12 ft. and dropped on to the plate. When less than 25 cwts. the drop is 15 ft. This constitutes a pretty severe test and one which will certainly find out any flaws in the anchor, if any exist.

Steel can be produced from the crucible furnace, open-hearth furnace, converter process, and electric furnace. Although there are still a few firms producing steel castings from the crucible furnace, the amount produced is only a very small percentage of the total output, and as a medium for the production of steel castings, the crucible furnace can be practically ignored. The open-hearth furnace is specially adapted for dealing with very heavy castings, whilst the electric furnace and converter process are ideal for the manufacture

of small and medium-sized castings. Being connected with a firm using the Tropenas converter, it is proposed to confine any remarks to that particular process. Including tapping and casting, the firm's converter will produce 45 cwts. to 50 cwts. of steel every 30 minutes, approximately. When the heat of steel is required solely for small work the whole heat is poured into a large ladle, and distributed where required by means of small ladles of approximately 1½ cwts. capacity. Very little trouble is experienced even with castings of very thin section, which indicated the considerable heat generated during the blowing of the steel. Suitable charges of pig-iron and steel scrap are melted in the cupola. The area of the cupola well is designed to correspond with the amount of metal required to bring the converter to its correct position for blowing. After sufficient metal has been melted the tapping hole is opened and the metal conveyed to the converter by means of the spout which is worked on a pivot and which is moved out of the way after sufficient metal has been obtained. Having received the required amount of metal the converter is tilted back to the desired position, this being ascertained by the operator looking through the tuyere boss and just allowing the convex edge of the metal to appear over the edge of the tuyeres. The angle of the converter being noted, the tuyere-box cover is fastened on and the blast applied. At the beginning of the blow sparks and smoke should come out of the mouth of the converter, but very little flame. The sparks are large and scintillating, the smoke noticeable but not too voluminous. An experienced operator by noting the appearance of the sparks and smoke can tell during the first minute or so of the blow whether the silicon content is correct or otherwise, and if it will be necessary to adjust the metal up as the blow proceeds. If the silicon content is too low and the operator fails to adjust it with ferro-silicon, a cold heat is the inevitable result. In 3 to 5 minutes the character of the sparks change and become non-scintillating, and a flame appears at the mouth of the converter. During the next few minutes the flame increases in brightness and volume until what is known as the boil occurs. At this period the flame should be carefully watched, and if there is a tendency to throw out metal the blast pressure should be reduced to a safe limit. A certain amount of slag is always seen projecting from the mouth of the converter, and this should be removed if it interferes with the observation of the flame. After the termination of the boil the flame dies down and remains in a quiet condition for some minutes. Then rises again to become particularly bright and clear, and finally rapidly dies down. At this stage the blow is ended, the converter is tilted to a horizontal position and the blast turned off. The time taken from beginning to end of a normal blow is about 20 minutes.

A battery of crucible furnaces are used in conjunction with the converter, and the required amounts of FeSi, FeMn and pig-iron are melted in these furnaces and added to the bath which is practically pure iron, to give the desired analysis. When making manganese wheels, manganese links, crusher jaws, etc., this procedure is slightly altered. Knowing the capacity of the ladle, the requisite amount of FeMn is put into the ladle and sufficient of the bath added to give a Mn content of from 11 to 14 per cent. It is not always possible to utilise the whole heat for manganese castings, and when such is the case the surplus can be used with suitable additions, for magnet castings or mild-steel castings, illustrating the adaptability of the converter process. The merits of steel produced by the Tropenas converter are illustrated by the results of two typical test bars recently pulled. The first gave 30.2 tons per sq. in. tensile, associated with a 35 per cent. elongation and 180 degs. unbroken bend test; the second gave a higher tensile of 42.8 tons per sq. in., associated with 21.0 per cent elongation. Some engineers dislike castings produced by the Tropenas converter, their objection, as is well known, being the sulphur and phosphorus contents, but by careful selection of pig-iron and scrap and a suitable cupola these impurities can be kept down to a safe limit.

Hints on Cupola Practice.

By A. SUTCLIFFE, M.Inst.Brit.F.

There is no branch of ironfounding more worthy of study than cupola melting, but it is generally the most neglected. The author has followed the cupola processes in many foundries, and has often been astonished at the poor results which are obtained, both in respect to quantity and quality of the metal delivered. Many founders are struggling with difficulties in the shape of defective or waster castings, and are looking everywhere but in the correct direction for the cause. There are some foremen and more melters who have a very poor idea indeed of the quantity of iron their cupola should deliver in a given time or during one heat, and are but indifferent judges of quality of the metal when tapped. Iron has been seen at the cupola spout which was undoubtedly dull and sluggish and obviously the product of a really badly-worked cupola, but which the melter designated "good hot" iron. The shade of colour, apart from other phenomena, in molten iron, between clear yellow and white, are perhaps not easily distinguished except by the experienced eye, though they represent great differences of temperature; but the difference between white iron and iron at yellow-red temperature should be readily recognised. It is a noticeable fact that foundry foremen are averse to criticism of recently-melted iron, emanating no doubt from the knowledge that at that stage it is impossible to alter it in any way, and that it is their duty to make the best of it, whatever its condition.

The principal causes of bad melting are faulty quantity and faulty delivery of blast, associated with a poor arrangement of the charge in the furnace. The rule is that a cupola of a given size (interior diameter) should be worked to deliver a certain quantity of iron within a definite time, which should under no circumstances be altered. This is because, for all intents and purposes, there is really only one correct system of getting iron of the correct quality from one particular cupola, *i.e.*, one volume and velocity of blast and one arrangement and weight of fuel and iron to bring the iron charges directly into the melting zone at the correct time and under the best conditions. The author is of opinion that where adjustments are required in the quantity of iron which the founder requires to be delivered to him at the commencement of his casting operations, they cannot be made satisfactorily by alterations of blast or of weight and disposition of charges in one cupola except within inconsiderable limits. An alteration in the cupola capacity is really required. This involves that if the foreman requires to use iron more quickly than his cupola will deliver it when working at its normal rate of output, he has practically no remedy, but if he finds it inconvenient to deal with the iron as fast as melted, he can tap it into ladles, which, if the iron is truly hot, will hold it for a considerable time in good casting condition, when covered with carbon, *sawdust* and *common blacking*, mixed equal parts. If kept well away from draughts and cold air, metal so treated can be kept hot quite a long time, and in good casting condition. The founder, then, will commence by establishing the quantity of iron his cupola ought to deliver, say, within the first hour, and if he is uncertain on the question he should seek expert opinion.

Ascertaining Blast Requirements.

Suppose the quantity of iron that has to be melted is known, the next question is the blast. It may safely be assumed that an amount of air somewhere between 30,000 and 35,000 cub. ft. is required to melt each ton of iron, so that if four tons has to be delivered by the cupola in the first hour, four times that quantity of air must be blown into the cupola in that time. A calculation gives the quantity per minute required, and a blower or fan must be then selected which is guaranteed to deliver that quantity. The principal makers of blowers or fans will always give the capacities of any machine in terms of cub. ft. of air per minute delivered by a given number of revolutions at the blower or fan outlet. But the founder must remember that a suitable allowance must be made for loss of air by friction and by bends in the connecting pipes, and possibly by leakage at joints in the blast pipe and wind box.

Each founder must estimate this for himself, and select his own method of providing against it. He may either, so far as the loss by friction is concerned, arrange that his blower or fan shall deliver the extra amount of air required, or increase the size of his blast pipes by the required amount.

Practical Details.

Granted the correct quantity of air delivered into the wind box and the tuyeres so arranged as to ensure its passing into the cupola at the correct velocity the scheduled quantity of iron should be melted. If it is not then the founder must look for the fault in the weight and arrangement of his charges, and it will be necessary for him to experiment until he finds the necessary height of coke bed and size of alternate charges of fuel and iron, which will bring the latter always exactly into the zone in the furnace in which it will be melted most advantageously. During the period of his efforts to get the maximum output of good iron from his cupola, the air supply should not be changed, either as to quantity or velocity; the changes should be run on the quality or quantity of the fuel and the weight and arrangement of the charges. The average foundry foreman works by a system of blast pressure, and if his melting is poor there is at once a cry for more pressure, but without regard to the volume of air supplied, and it is the volume, *not the pressure*, of the blast which is the governing factor in good melting. The best melting is done where the correct quantity of air required to melt the scheduled quantity of iron in a given size of cupola, is discharged into the cupola at the lowest velocity compatible with its diffusion amongst the fuel at, and just below, the melting zone. It is not asserted that increased velocity of blast, other things being equal, is not able to raise temperature and accelerate melting, but it is insisted that increased velocity is undesirable, since it may have a marked effect on the iron quite out of place in a cupola, which is a melting furnace, pure and simple. Iron will be hardened in a certain ratio with the velocity of the blast, and such a hardening is extremely dangerous, and may ruin the castings. It should be clearly grasped that the only function of the cupola blow is to promote combustion of the fuel.

If the blow begins to have a marked effect on the quality and chemical composition of the iron it resembles a Bessemer blow—a process designed to effect a totally different purpose. Moreover, high blast velocity for cupola work generally means great waste of power at the blower or fan. A fact easily discoverable on investigation.

Numerous Large Tuyeres Advocated.

It is often stated that unless the air is driven into the cupola at great velocity, it will not find its way to the centre of the fuel, but it is thought this difficulty is greatly exaggerated. With few tuyeres of small area, which generally accompany high blast pressure, the danger of stoppage is obviously great. The way to ensure free entrance of the blast to the cupola is to increase the tuyeres in number and area, as there is less chance of a large opening becoming choked than a small one, and of six tuyeres becoming choked than three. As a general rule it will be found that changes in the percentage of fuel used, made in order to alter the melting are not attended with good results.

There is only one percentage of fuel which will give the best results in any cupola, and that should be discovered (in conjunction with the quantity of air as previously described) and adhered to. The foreman should be encouraged in this work rather than in the direction of finding the lowest possible amount of fuel with which iron will melt in his furnace. The latter may be very false economy when examined in conjunction with the quantity, quality and temperature of the iron tapped.

The system indicated appears so simple and elementary that one might almost be scoffed at for mentioning it, but as a matter of fact it is very seldom found to be employed.

Elements of Successful Polishing.

By Bradford H. Devine.*

Design of the Article to be Polished.

Polishing begins in the drawing office. Wheels of large diameter are more economical to use than wheels of small diameter. The article to be polished should be designed, therefore, to eliminate all unnecessary projections, depressions, angles, recesses or reverse curves, which can be polished only with narrow or small wheels and at excessive costs. Usually the cost of any extra metal involved can be more than offset by the saving in polishing.

Relation of Preceding Processes to Polishing.

When castings are to be polished without previous operations, they should be as free as possible from excessive sprues, ragged edges, lumps or other surface defects. With forgings, as much scale as possible should be removed. In drawn or stamped work, deep drawing marks or scratches caused by imperfect dies should be eliminated by correcting the dies. Work which is tooled, or which is ground on solid wheels, should be so processed that the surfaces will not be too rough. Deep tool or grinding marks necessitate removal of too much metal, to reduce the entire surface to the level of the bottom of such marks.

Work should be delivered to the polishing department in such condition that it will not be necessary for that department to correct the errors of other departments. The cost of correction in the polishing department usually exceeds that in the department where the incorrect condition originates.

In an axe factory the forged axe when it left the dies was true to contour, but with an extra thickness of metal to allow for grinding off the scale. The solid-grinding operation to remove the scale destroyed the contour and left the surface in scallops or waves. It required at least three operations, which should not have been necessary, to restore the contour and prepare the surface to take a polished finish. The installation of a cheap and simple process for removing the scale while the metal was red hot eliminated the solid grinding and several polishing operations, and greatly reduced the cost of finishing.

Absence of vibration is necessary for successful polishing. A polishing wheel, like any high-speed unit, is susceptible to vibration. A vibrating wheel makes scratches which cost time and money to remove. A polishing wheel works at best efficiency only when the entire face of the wheel comes in contact with the article being polished, at every revolution of the wheel.

Good dust-collecting systems should be installed so that the dust from the wheels may be quickly removed. Abrasives will fly from the wheels; and if the grains from the coarse wheels come in contact with work undergoing finer operations, deep scratches will be caused. It costs money to take these scratches out.

Polishing Machines.

Rigidity and durability are the factors of greatest importance in polishing machines. The items which enter into these factors are the size of the machine, its weight, floor area of the base, design and construction, size, location and type of bearings, and shaft material and diameter. With improved glue handling methods, peripheral speeds of from 7,000 to 10,000 ft. a minute can be used, requiring a better class of machines than those used a few years ago, when peripheral speeds rarely exceeded 5,000 ft. a minute.

All buffing wheels, and a great many polishing wheels, wear down in diameter. They operate, therefore, at a constantly reduced efficiency, due to decreased surface speeds. Direct current, permitting the use of variable-speed motors, is found in only a few localities. To transform alternating to direct current is too expensive to be generally satisfactory.

The best answer to this variable-speed question seems to be an electric motor built into, or attached to, the column of the machine and belted to the wheel shaft. Another form of variable-speed machine recently introduced uses bevel gears, in which, by changing the gear ratio, variable speeds are secured.

Automatic Polishing.

Automatic polishing is rapidly taking its place in the industry for processing large productions of flat pieces, or pieces having a portion of their surfaces flat. Flat parts of pliers, or such articles as plane blades, flat-irons, monkey and pipe wrenches, sheet metals, strip steel, flat bars, knife blades are samples.

While at present interest in the automatic polishing of flat work predominates, round bars, tubes, and contoured pieces are also being successfully produced on automatic machines. The variety of work capable of accomplishment by automatic processes is rapidly increasing.

Many conditions arise not present in hand work, for the machine is without the human "feel." The work and the wheels are in fixed positions in relation to each other, and the machine cannot correct imperfections in the work as the hand operator can. It is necessary that the work be brought to automatic machines in better condition for polishing than with hand-work. That automatic polishing reduces costs and speeds up production is shown by examples. On one automatic machine hot-air registers 40 in. square are being solid-ground, flexibly ground, and polished ready for enamel (a ten-wheel operation), in 5 minutes 40 seconds each. On another machine 2,400 flat-iron bottoms an hour are finished. In another case 3,500 small flat pieces an hour are turned out by one man operating three machines. In the steel trade a ton of cold-rolled sheets 36 × 60 in. has been polished, one side at a time, in 38 minutes.

Polishing Tools.

Polishing wheels, unfortunately, have been considered and purchased altogether too much from the standpoint of merchandise. The fact that they are tools of considerable importance has been somewhat lost sight of. In their manufacture too much consideration has been paid to something to sell at a competitive price, rather than to the development of the tool itself in proper relationship to the work it is to do.

A wheel which has high spots on it, or is uneven on the face, will present only a part of the abrasive head to do the cutting. As a result the operator has to employ more time to reduce a given amount of metal—and time, as represented by operator's wages, is the most costly item in the whole operation of polishing.

A factor in wheel economy is the diameter and width of face of wheels. It is advisable to use a wheel as large in diameter as the article being polished will permit, thus to secure the maximum contact of the wheel with the work necessary to remove the greatest amount of metal at each stroke. Large wheels have less tendency to overheat than small wheels. Heat is generated only at the point of contact between the wheel and the work. On the large wheels the heated area has a greater opportunity to cool before returning to contact with the work.

It is also advisable, where possible, to use a face much wider than the piece being polished, so that the piece may be moved about on the face of the wheel and not wear the head in one spot. The use of wheels of large diameters and wide faces reduces the investment in wheels, because of the smaller number required. It reduces the cost of caring for wheels, and of re-heading them. It also reduces the time lost by operators in changing wheels.

Abrasives.

The abrasive grain, which does the actual cutting, is one of the two most important prerequisites of polishing. Glue is the most important, and the grain is secondary only because the grain cannot be given a chance to do its best work unless firmly bonded to the wheels by the glue.

For flexible-grinding operations the manufactured abrasives are far superior to emery. Examined under the glass, the manufactured grain appears much like sharp pebbles, uniform in size and containing no foreign matter. It differs from emery in being more uniform in hardness or temper. Each grain is so constructed that when properly bonded to the wheel it will fracture away piece by piece, each fracture presenting a fresh cutting edge until the grain is consumed. Wheels headed with manufactured abrasives have less tendency to glaze than those headed with emery.

An important feature in handling grains is the proper consistency of the glue for the different sizes of grains. If the glue is too thin for coarse grains it will not provide the proper body to hold the grains. If the glue is too thick for the finer grains the cut of the grains will be modified, a glazed condition of the wheel face will result, and wastage occur.

Glue.

Glue is the most important prerequisite of polishing. When it is realised that the abrasives glued to polishing wheels have to perform practically the same operation of grinding away or tearing down metals as solid, vitrified wheels do, it will be evident that glue, as the bond between the wheels and the abrasives, is the most important factor in polishing. The efficiency of the combination of the wheel and abrasive as the cutting tool depends almost entirely upon the strength of the glue bond. The ability to secure the desired finished surface, and the cost of securing that surface, depend upon the strength of the glue bond. In fact, glue is the keystone of successful polishing.

The glue which gives the most satisfactory results for polishing is the best quality, first-run, straight hide glue. The characteristics necessary are jelly strength, toughness, viscosity and—what is more important than anything else—flexibility. Many glues set hard and brittle, and are broken up and torn out by the bending action of the face of the wheel.

Two elements in glue handling must be recognised and controlled. One is heat, the other is bacteria.

Heat makes glue, and heat destroys glue. The maximum strength of the glue bond, which enables it to resist the frictional heat generated in polishing, is secured only by a proper control of heat in the preparation of the glue.

Glue loses 5 per cent. of its strength for every hour of heating. Laboratory tests have shown a loss of 67 per cent. of strength after 12 hours under heat. Tests of a high-grade glue, made by the United States Forestry Bureau, showed a loss of one-half the glue strength in 7 hours at a temperature of 176 deg. Fahr. Glue is in its strongest condition at a temperature of 135 deg. Fahr.

In applying glue to the wheel no draft of air should come in contact with the glue brush, for instant chilling and serious weakening of the glue will result. The wheels and abrasives, heated to at least 120 deg. Fahr., will allow the whole mass of abrasives, glue and the wheel to cool gradually, without detriment to the glue strength.

Glue hardens in the process of setting much as concrete does. Setting begins with the cooling, but continues long after the cooling has reached its stopping point. A wheel head may be cold in an hour or so, appearing to be ready to use. As a matter of fact, a minimum of 48 hours is required to complete the natural process of setting glue to its maximum strength.

A fact not apparently well known is that glue handling is a fight with bacteria, and again the question of heat comes in. Glue chemists tell us that the bacteria increase rapidly, consuming the strength of the glue, at temperatures higher than 140 deg. Fahr. This is recognised in the manufacture of glue, which is cooked at temperatures of about 140 deg., and then the temperature is reduced as quickly as possible in the process of solidifying the glue, to the point at which the bacteria become virtually inactive.

* President Devine Brothers, Co., Utica, N.Y. "Iron Age" abstract of a Paper read before a meeting of the American Society of Mechanical Engineers.

A Survey of Moulders' Troubles. *

By J. C. HALLAMORE.

The everyday troubles which are common to most foundrymen, and which are invariably the result of thoughtlessness or carelessness on the moulder's part, will not be dealt with in this Paper, as its author has picked out individual jobs which have come before his notice. After causing trouble and difficulties, these jobs have been thought out, and by altering the methods of production, can now be made successfully. Leaving aside scientific and metallurgical questions, this Paper deals with the plain moulding troubles which can be understood by any moulder. An endeavour will be made to classify these jobs under the following headings:—(1) Design; (2) metal failure; (3) wrong method of moulding; and (4) poor sand.

Design.

Moulding Large Flywheels 30 and 41 in. dia., 8 in. deep.—When initially considering this job it was decided to use an all-pig mix, as the boss and rim were very thick compared with the arms. The 30-in. wheel was the first cast, and after the job was set, the boss and rim were bared. The resulting casting was quite satisfactory. The trouble began with the larger wheel. Operations were carried out in the same manner as for the smaller wheel. When the casting was knocked out and brushed, it was found that all the arms had cracked. Before casting the next mould, the arms were thickened. The second casting was quite sound. No pattern was supplied for this job, the outside being strickled and the arms formed by cores.

Shaping Plates.—These plates are for rubber moulds, and the inside recess must have a perfect and smooth face when machined up. The sections of the casting were of uneven thickness. Only a slight alteration could be made to the thinner section to produce more evenness in section, as the customer wished to avoid extra machining. The casting has to be machined all over. The moulds were strickled out and the drags dried, the job being poured from two sides, with runners on top. The first casting when machined was porous on the thin section. For the next casting it was decided to insert a chill to densen the metal at this point. When the casting reached the fettling shop it was found that the chill had cracked the thin section. For the third casting it was decided that the metal used should be altered. One-third of No. 1 pig to two-thirds of No. 3 pig was used, and a good casting resulted. This job should perhaps come under the next heading, but after consideration it is thought it can be said that the design was not good from the foundry point of view, and this was the main cause of trouble.

Wrong Method of Moulding.

It occasionally happens that the first casting is a waster. In some cases this could be avoided if the moulding operations were altered. The first instance taken is the casting of bosses for W.I. wheels. Special boxes and tackle were made for this job, and at first it appeared that things were not going to be a great success. These wheels are made in sets of nine. The first lot moulded was cast green, and a very fine display of fireworks was given during the actual casting. The bosses were cast with a single runner 1 in. dia. on top. Hot metal and feeders were used when the moulds blew, but without much success. The next set of moulds was all stoved, and the resulting castings were satisfactory, the only difficulty being when dropping the wheels into the dried moulds, as the dried surface was inclined to crumble. It was found later that if only the copes were dried that was sufficient; and also a $\frac{3}{4}$in. dia. runner gave better results.

A bracket is another example of the same trouble, which can be classified under "trapped air and gases" which are unable to escape sufficiently rapidly. If the middle portion of the mould is dried, no trouble from "blowing" occurs. A pocket of ashes would perhaps serve the same purpose. Another example is a fire bar, 2 ft. long by 3 in. deep, with slots tapered from $\frac{7}{16}$ to $\frac{5}{8}$ in. These bars were for boilers, and must not have the slots bigger than $\frac{3}{16}$ in. at the top. When these bars were first moulded the percentage waste was very high from blown moulds. As is usual, these bars were cast in hard iron. The first thing discovered to prevent this waste was that no hard iron could be used, yet moulds cast in cheap scrap did not blow. Secondly, that all moulds must be dried in the core stove to ensure obtaining a fine slot. To some it may seem absurd to take all this trouble over fire bars, but when one considers that the waste is now practically nil compared to nearly 50 per cent., the trouble taken was worth while. Many boys seem to have a great dislike to making fire bars and think that the job is beneath them, yet it can be truly said that they require more moulding skill than many machine-part jobs.

When first making 14-lb. ball weights, trouble was experienced from "drawing." These weights were run on the side with a large runner and a good down-right and fed. Here again hard iron could not be used. If cast in cheap scrap and the top mould sprigged with a small vent to assist the escape of gases, no trouble occurs.

Poor Sand.

From Papers appearing at various times in THE FOUNDRY TRADE JOURNAL it is pleasing to note that foundrymen are realising the important part sand has amongst raw materials. Much data is still needed before sand troubles are overcome. The small foundry cannot afford to carry out laboratory tests in the manner of the larger ones, and has to rely on the look and feel of the sand.

During the author's apprenticeship it was decided to try a new batch of sand. A load was delivered, and matters proceeded normally. After the first cast, when the castings were knocked out, it was found that nearly every job had scabbed, particularly the loam cores for some pipes. At first it was thought that the trouble occurred from sand badly mixed or mixed in wrong proportions, and this was noted and altered, but without success. For a short period scabs ruled the foundry. Finally a truckload of the previously used sand was ordered and delivered, and the scab trouble disappeared. The sand that caused this trouble had too large a percentage of clay and did not allow the free escape of the mould gases. For those who are unable to afford a laboratory it is good practice to get a reliable sand and to persevere with it. Unfortunately, this can only be secured by perhaps at times bitter experience. This is an example to show that sand is a material that has to be reckoned with.

* A Paper submitted to the East Midlands Section of the Institute of British Foundrymen, Mr. H. Pemberton presiding.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Britain's Largest Aluminium Casting.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The writer noted with respect the illustration of the large aluminium alloy casting you refer to in a recent issue. Your doubt as to the use of the superlative is, however, well placed. There is one foundry at least dealing as a normal routine with aluminium alloy castings weighing between 500 and 850 lbs., and that foundry will shortly be casting single pieces up to a couple of tons in weight. Castings up to 600 lbs. in pure aluminium are by no means uncommon. From other work inspected in this and other countries it can definitely be stated that the casting illustrated is by no means a record; but it is all in the right direction, and so more power to the elbows of those who produced it.—Yours, etc.,

GEORGE MORTIMER,
Managing Director,
WILLIAM MILLS, LIMITED.

Grove Street, Birmingham.
November 15, 1927.

THE ANNUAL MEETING of the British Cast-Iron Research Association is to be held at the Engineers, Coventry Street, Piccadilly, London, W., on December 8, when the report and balance-sheet will be presented.

Dressing Shop Practice.

By J. H. WIGGLESWORTH (National Organiser, Iron, Steel and Metal Dressers' Trade Society.)

After reading the statement of Mr. W. B. Lake in his Presidential Address to the London Section of the Institute of British Foundrymen to the effect "that in an engineering shop, *the profits are made or lost in the foundry*," the author thought of the many times he had heard statements similar to the above, and wondered how many tons of castings had been saved from the "scrap heap" by the skill and patience of the oft-despised dresser.

Looking back over 30 years of practical experience the author is more than ever convinced that many employers do not place the proper value on a well-organised dressing shop.

It is realised that dressing shops can never be drawing-rooms, and whilst appreciating to the fullest extent that quite a large number of employers have re-modelled their departments on up-to-date, hygienic conditions, yet there still remain many foundries where the facilities provided for the dressing of castings are the most primitive imaginable. The impression seems to be general that the whole floor space should be given over to moulding, and nothing else matters.

Typical Cases.

A description of some of the conditions recently encountered in dressing shops may be interesting. Primarily there is the case of a steel foundry, in which men are working with up-to-date pneumatic hammer plant, but the men are operating either on their knees, with castings on the floor, or on heaps of sand. A second relates to a dressing shop situated just outside the moulding shop, where one man is breaking pig-iron, and another making up the back of the furnace, whilst the dressers are doing their work as best they can, under the most distressing conditions. A third is attached to a really up-to-date foundry, but at the dressing end, heaps of sand, core grates, heads and runners, and on the top of these the men are expected to dress the castings.

Obviously these conditions do not make for economy. Rather is the exact opposite the truth. Increased cost of output, badly finished castings, disgruntled workmen, who are unnecessarily fatigued, and by far the most important, a number of preventable accidents.

How often have we heard the remark: "It could not be helped, the log slipped and the casting came down on his foot!" Is this exactly correct, could it not have been prevented? Obviously it could!

"Loss of Eye" Accidents.

But the most distressing and also the most alarming, on account of the number of cases brought to our notice, is the accident resulting in loss of an eye.

Many of these accidents are traceable to the overcrowded conditions, under which the men have to work. It is well known that employers are really concerned regarding these accidents, and many of them have from time to time provided goggles for the dresser to wear when working, but as a practical man the author submits that goggles are not suitable for the dressing of castings.

For a remedy of the many complaints relating to dressing shops, it is suggested to the employers to provide ample room in which to do this work. It is folly to be obsessed with the idea that it is only the making of a casting that matters. Their dressing is equally important.

Given plenty of floor space, with facilities for taking away the scrap, core irons, sand, etc., the author is confident that the effect would be apparent in the shape of higher output, improved quality of work and reduction in the number of accidents.

[We would draw the attention of the author to the latest development in fettlers' goggles which cover the following points:—(1) Defective eyesight corrected; (2) provision against clouding through sweating; (3) absolute comfort; (4) adequate ventilation; (5) real protection against chips; and (6) limited protection against any ultra-violet rays.—EDITOR.]

Trade Talk.

JOHN LE BOUTILLIER, LIMITED, 57, Bishopsgate, London, E.C.2, have removed to 13, Rood Lane, London, E.C.3.

DURING THE EARLY hours of Friday, November 11, the premises of Toy & Company, founders, engineers, etc., at Helston, were discovered to be on fire. The outbreak occurred in the engine house, which was destroyed.

IT IS ANNOUNCED that the leading United States copper producers have effected an organisation, the Copper Institute, to promote closer collaboration in the copper industry and to co-operate with the Copper and Brass Research Association and also with the American Bureau of Metal Statistics.

HICK-HARGREAVES & COMPANY, LIMITED, Bolton, have secured the British manufacturing rights of Masons' valves, with the patents, and are proceeding immediately to manufacture. The valve will be known as the "Hick-Mason" valve. These valves mark an important development in valve design, and are designed to withstand the highest pressure and temperatures.

ON SATURDAY, NOVEMBER 12, Mr. R. Carrington Walthew opened a new works canteen at the Newton Heath Glass Works, Manchester, of Butterworth Brothers, Limited. Upon arrival Mr. Walthew was conducted over the plant. He was then received at the canteen premises by the chairman and secretary of the canteen committee, which the workpeople have elected entirely from among themselves. The premises occupy two floors, and in declaring them open Mr. Walthew spoke of the consideration always shown by the firm for the comfort and welfare of those in its employ.

MR. W. FARMER, 195, Upper Thames Street, London, E.C., the hon. secretary of the Royal Metal Trades' Pension and Benevolent Society, announces that the Tenth Annual Whist Drive in aid of the funds of the Society, will take place (under the direction of the Auxiliary Committee) at the Finsbury Town Hall, Rosebery Avenue, E.C.1, on Saturday, December 3, 1927. The chairman and M.C. will be Mr. E. H. Farris, of Van Zanten & Farris, Limited. Tickets of admission (5s. each, including refreshments), may be obtained from the chairman, members of the auxiliary committee, the stewards, or from the offices of the Society, 195, Upper Thames Street, E.C.4. Much needed contributions in aid of the funds will be received, and may be sent to the chairman, stewards, or the secretary

THE ELECTRIC FURNACE COMPANY, LIMITED, of 17, Victoria Street, London, S.W., have recently received orders for five Ajax-Wyatt furnaces for the Compagnie Française des Métaux, Serrifontaine, France, and for two Ajax-Wyatt furnaces for the Société d'Electrométallurgie de Dives. They have also just shipped six Ajax-Wyatt furnaces to the Tréfileries et Laminoirs du Havre, France. Each of these furnaces is of 600 lbs. capacity, and is required for melting brass. They have also recently received an order for a 150-K.V.A. Ajax-Northrup high-frequency furnace for steel melting from the Soc. Anon. Commentry-Fourchambault & Décazeville, Imphy, France, and are now erecting a similar furnace for the S.A. des Etablissements Jacob Holtzer, Unieux. These furnaces, which are of the same type as that recently started at the works of Edgar Allen & Company, Limited, Sheffield, are each of 450 lbs. capacity, and are to be used for melting steel.

Company Reports.

South Durham Steel and Iron Company, Limited.—Dividend 1s. per share (5 per cent.) on ordinary shares for year.

Brown Bayley's Steel Works, Limited.—One year's dividend on preference shares, free of tax, for year to July 31, 1925.

Dorman Long & Company, Limited.—Dividend on 6 per cent. cumulative preference shares for half-year ended September 30.

John I. Thornycroft & Company, Limited.—Dividend, 3 per cent. on preference, making 6 per cent. for year; 7½ per cent. on participating preferred ordinary, and 6 per cent. on ordinary; carry forward, £51,669; profit, £65,626.

Dickson & Mann, Limited.—Capital now amounts to £25,834. Assets, amounting together to £59,678, written down by £32,978, and balance at debit of profit and loss account written down by £16,187, leaving at debit of that account £1,480.

Steel Company of Scotland, Limited.—After meeting all charges and providing £3,000 for depreciation of colliery plant and exhaustion of minerals, there remains at credit of profit and loss account £110,494, which proposed to carry forward.

Company Meetings.

Henry Meadows, Limited.—The annual meeting was held at Wolverhampton on November 10, MR. A. G. JEFFS (chairman) presiding. In moving the adoption of the report, the chairman said that, in order to cope with the increased demand, it was necessary during the past year largely to increase the plant. As a result of those additions, sales increased approximately 45 per cent. Additions were also made to the buildings as required, to provide accommodation for the new machines. The financial position of the company was sound. There was now no indebtedness other than to trade creditors, the assets were conservatively valued, and the buildings and plant had been maintained in a state of efficiency and proper depreciation charged. No "goodwill" item appeared in the balance-sheet, but it went without saying that a very valuable "goodwill" existed.

Bolckow, Vaughan & Company, Limited.—The sixty-second annual meeting was held at Manchester on November 9, the chairman, the HON. ROLAND D. KITSON, presiding. The chairman reminded the shareholders that the accounts dealt with 5½ months of the seven months' coal stoppage, there being thus hardly six months of proper working. They had transferred to the general reserve from the repairs and renewals fund £68,308, which was in excess of their actual requirements, bringing the general reserve up to £256,441. Against the general reserve thus increased they had charged the sum of £243,240. This represented the cost of maintaining the collieries, mines and works of the company, which were laid idle in consequence of the stoppage. The whole stoppage involved the company in an expenditure of £312,231, exclusive of the interest charged while they were not working. Local taxation accounted for over 20 per cent. of this cost, namely, £66,000, or nearly £1,800 per week; but he was glad to say they had recently obtained relief by reductions of their assessments. Including local taxation, the preservation and maintenance of their collieries cost over £5,000 a week, the mines and quarries £450 a week, and the iron and steel works over £3,000 a week for the thirty-seven weeks their collieries lay idle.

Millom & Askam Hematite Iron Company, Limited.—MR. G. MURE RITCHIE (the chairman), in proposing the adoption of the report at the ninth annual meeting, said the debenture stock stood at £101,520. Few companies having assets of similar value had so small a debenture debt. He wished again to emphasise the directors' view that "investments in allied and other companies," standing at £649,671, were worth more than the figures at which they appeared, and in framing the balance-sheet these investments had been very carefully considered. As regards trading losses made by allied companies, there had been, generally speaking, a satisfactory transformation from the coal strike year, and if in all cases the results of that period had not been completely wiped out by subsequent profits, progress in that direction continued. The profit and loss account figures showed that on about nine months' operations there was a profit of £84,877, from which must be deducted not only debenture redemption and interest and preference dividend, but also the coal strike loss of £20,318, incurred in the previous three months. The final result was a net profit of £55,255, as against £1,314 for the previous year. Obviously, but for the coal strike, the profits would have been larger. Notwithstanding, due to that cause, the suspension of ore extraction, the company's Florence mine had given satisfactory results. It was the first to resume ore-getting, and during the stoppage everything was done to keep the mine at the maximum pitch of efficiency and to simplify the handling of ore, with the result that they were now in a position to obtain a larger output with corresponding reductions in costs, and the mine continued to be worked in a thoroughly sound and scientific manner.

Iron and Steel Output in October.

The national Federation of Iron and Steel Manufacturers report that the number of furnaces in blast at the end of October was 162, a net increase of two since the beginning of the month, four furnaces having been put into blast and two blown out. The production of pig-iron in October amounted to 596,300 tons, compared with 591,500 tons in September and 596,100 tons in August. The October production included 193,700 tons of hematite, 198,800 tons of basic, 148,300 tons of foundry and 29,400 tons of forge iron.

The production of steel ingots and castings amounted to 699,000 tons in October, compared with 777,000 tons in September and 643,100 tons in August.

Contracts Open.

Alnwick, November 28.—Nine yards of 6-in. cast-iron socket pipes. The Clerk, 24, Fenkle Street, Alnwick.

Christchurch, N.Z., March 13.—Nine electric centrifugal sewage pumping plants, each plant consisting of two pumps with electric motor direct coupled to each pump, for the Christchurch Drainage Board. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,457.)

Johannesburg, December 10. — (878) 10 miles of 0000 s.w.g. (0.4-in. dia.) round section hard drawn copper trolley wire, for the Municipal Council of Johannesburg. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,468.)

London, S.E.1, December 2.—(1) 194 pairs of wheels and axles for carriages; and (2) 33 sets of body fittings, etc., for rolling stock, for the Indian Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Fee 5s. per set, non-returnable.)

London, S.E.1, January 5.—(7) (462,000) Cast-iron sleeper plates; (8) (231,000) tiebars; (9) (308,000) gibs and (616,000) cotters; and (10) (616,000) keys, for the India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Fee 5s. per set, non-returnable.)

Manchester, November 28. — Steelwork, for the Tramways Committee. The City Architect, Town Hall, Manchester. (Fee £1 1s., returnable.)

Manchester, November 28.—(No. B.58) High-pressure steam and feed-water pipework, for the Corporation. Mr. H. C. Lamb, chief engineer and manager, Electricity Department, Town Hall, Manchester. (Fee £2 2s., returnable.)

Melbourne.—One tenoning (30-in.) machine, including motor-starting apparatus, etc., for the Commissioners of the Victorian Government Railways. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 471.)

Morpeth, December 3.—1,025 yards of 2-in., 3-in. and 4-in. cast-iron pipes, with valves, hydrants, etc., for the Borough Council. Mr. J. Davison, borough surveyor, Tower Buildings, Morpeth.

Sydney, March 5.—One 4-motor electric travelling wharf crane, for the Department of Works and Railways. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,493.)

Personal.

AT THE ANNUAL MEETING of the Central Board of the Shipbuilding Employers' Federation, Mr. J. T. Batey, of Hawthorn, Leslie & Company, Limited, was elected president for the ensuing year, in succession to Mr. John Barr, of Vickers, Limited, who retired after three successive years of office as president. Mr. A. J. Campbell, of Wm. Beardmore & Company, Limited, and Mr. J. H. Edwards, of the Middle Docks and Engineering Company, Limited, were re-elected vice-presidents, and Mr. A. L. Ayre, of the Burntisland Shipbuilding Company, Limited, was also elected a vice-president to fill the vacancy caused by the election of Mr. Batey to the presidency. Mr. W. A. Henderson, of D. and W. Henderson, Limited, was appointed chairman of the Conference and Works Board of the Federation, in place of Mr. A. L. Ayre, with Mr. G. W. Barr, of Vickers, Limited, as vice-chairman.

Wills.

NELSON, S. C., of Culra, Co. Down, engineer	£10,043
ELLIS, S. J., chairman of James Jackson & Company, Limited	£22,013
PENNINGTON, D. J., Levens, Westmorland, a director of Gilbert Gilkes & Company, Limited, and the Canal Iron Works, Kendal	£10,783
PRICE, J., of Roseberry, Spring Hill, Halesowen, Worcester, and of J. Price & Sons, Limited, manufacturers of nails and spikes	£15,391

New Czecho-Slovak Ore Trading Company.—The Berg- und Hüttenwerks Gesellschaft of Brünn, in Moravia, in association with the Nordische Erzkontor G.m.b.H., of Lübeck, and the large merchant firm of Alfred Schmidt, in Brünn, have formed a new Company under the name of Ferrochemia G.m.b.H., with registered offices in Brünn, for the purpose of trading in iron ores (principally Swedish) and manganese ores.

Iron and Steel Markets.

Pig-iron.

MIDDLESBROUGH.—Conditions in the Cleveland iron industry continue much the same as previously reported, buying in bulk for the current year having practically closed, while the home demand at present is principally confined to small parcels just sufficient to carry over immediate requirements. The long-expected resumption of business with Scottish consumers has so far failed to materialise, despite the more favourable terms extended by the Cleveland ironmasters, and it is feared that this market will remain closed to Tees-side pending the absorption of heavy stocks and orders for later delivery held by Continental makers. It is, however, satisfactory to learn that the foundries are becoming rather more busy than they have been, and the demand for Cleveland iron in the immediate neighbourhood has undergone some improvement since foreign prices are no longer competitive. A further important factor from the sellers' point of view is that prices remain at steady levels, thus giving buyers the courage which is born of confidence, and whilst most of the business placed is for prompt delivery, a few small sales are reported as far ahead as the end of June next. Current quotations are:—No. 1 Cleveland foundry iron, 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. The foregoing are home prices, and are reduced 2s. 6d. per ton for Scottish or foreign business.

The market for hematite on Tees-side is without signs of improvement, the home demand continuing quiet, barely sufficient, in fact, to absorb the present limited output of furnaces, while quotations are virtually nominal at 71s. 6d. for East Coast mixed numbers and 72s. per ton for No. 1 quality. On the North-East Coast Bessemer mixed numbers are still at 72s. to 73s. per ton at works.

LANCASHIRE.—The demand for foundry pig in local markets is, as is usually the case at this period of the year, confined within narrow compass, with prices fairly steady on the whole. Both Derbyshire and Staffordshire No. 3 qualities are well held at 73s. 6d. to 74s. and 73s. 9d. per ton respectively, with Cleveland makes for delivery Manchester or equal at 80s. 8d., and Scottish for delivery round 89s. per ton.

THE MIDLANDS.—Inquiries for foundry pig at Birmingham this week have been in limited volume, with prices at about previous levels. The current price for No. 3 Derbyshire foundry is from 65s. to 66s. 6d. at the furnaces. Northamptonshire No. 3 is offered at between 60s. and 61s., and North Staffordshire round about 65s. Many of the ironfounders find a distinct falling-off in the volume of orders, and are not at all anxious buyers.

SCOTLAND.—The quotation for Scotch pig-iron is now a shade easier on the basis of 72s. for No. 3 foundry at furnaces, and some of the pig-iron makers report that a few of their customers, recognising that the price is at a very low level, are prepared to buy moderate quantities ahead.

Finished Iron.

Demand for most classes of finished material is still on a disappointing scale, with little possibility of a change for the better until after the turn of the year. In South Staffordshire the inquiry is only small and irregular, specially so for crown and cheaper iron. The quotations for the former continue to vary considerably from £9 7s. 6d. to £10 5s., whilst nut and bolt iron is round about £9 delivered. Part time operations only are possible. Continental bolt iron is quoted at £5 15s. to £5 17s. 6d. delivered Darlaston district, and with a fair amount of success. No heavy tonnages are being booked, and the nut and bolt trade, generally speaking, is very quiet. Staffordshire marked bars remain at £13 at makers' works, and the mills making this grade of iron are moderately occupied. In Lancashire, orders for bar iron since last reported continue on an unsatisfactory scale, the demand being almost wholly of a hand-to-mouth description. So far as prices are concerned, however, these remain at the previous level, Lancashire crown bars being on offer at £10 per ton, and seconds at £9 10s. Merchant parcels of crown bars are quoted on the basis of 14s. per cwt., less 2½ per cent., and including delivery to buyers' works.

Steel.

Little improvement can be noted in the market for semi-products, English billets and sheet bars being quoted at £6 per ton and up, and Welsh supplies from £5 15s. delivered this area. With regard to Continental semis the works quotations for billets in soft Thomas quality are round about £5 5s. Blooms are £5, and sheet bars £5 6s. 6d. delivered. The Germans are anxious sellers at the moment and they are quoting one or two shillings above these prices. There are speculative offers from merchants for billets showing some advantage in price on these quoted. The prospects of any great improvement in the trade this year are now very questionable. The tinplate market, although on the quiet side, has been more active, and a noticeable increased volume of business has been done. Prices, in view of a possibility of a stabilised price, are firmer.

Scrap.

In common with most other foundry materials, the demand for scrap metals at this season is more than usually quiet, with few transactions of bulk supplies placed by consumers in the various markets. Few changes in quotations are reported, but on Tees-side, where there is a shortage of heavy cast iron, the price has advanced from 61s. per ton last week to 62s. 6d. per ton, with good heavy machinery quality a shilling higher at from 65s. to 66s. per ton. In Scotland machinery cast-iron scrap is quoted 67s. 6d. for furnace sizes, and ordinary at about 60s. to 62s. per ton, with cast-iron chairs offered around 65s. per ton and light cast-iron scrap at 57s. per ton, all delivered consumers' works.

Metals.

Copper.—Business in the section dealing in standard cash copper continues the most active in the markets for base metals, with prices steadily advancing week by week, quotations last week showing an advance of about £6 above the lowest level of the year. This remarkable improvement may be attributed to the tardy recognition of the rapid depletion of stocks within the last few months on both sides of the Atlantic. There was another decrease in the U.K. stocks last month, bringing down the total to 15,383 tons, which, as compared with the beginning of this year, indicates a shrinkage of fully 19,000 tons.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £59 11s. 3d. to £59 12s. 6d.; Friday, £59 16s. 3d. to £59 17s. 6d.; Monday, £59 13s. 9d. to £59 16s. 3d.; Tuesday, £59 12s. 6d. to £59 13s. 9d.; Wednesday, £58 13s. 9d. to £58 15s.

Three Months: Thursday, £59 13s. 9d. to £59 15s.; Friday, £59 17s. 6d. to £59 18s. 9d.; Monday, £59 15s. to £59 17s. 6d.; Tuesday, £59 15s. to £59 16s. 3d.; Wednesday, £54 18s. 9d. to £59.

Tin.—Movements in the market for standard tin of late have disclosed a steadier tendency, although so far the reaction has not been largely influenced by the more satisfactory statistical position disclosed in the recent returns. With regard to the future prospects of the metal, we may commend to notice the opinion of Lord Askwith, who at a recent meeting of the London Tin Syndicate, referring to the threatened tin famine, said that the present situation is not without much danger, which any further setback will only increase. The greater the fall, he said, the more violent is the reaction likely to be; there might then be a serious danger of the price getting beyond control.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £262 12s. 6d. to £262 15s.; Friday, £264 to £264 5s.; Monday, £267 to £267 5s.; Tuesday, £267 to £267 5s.; Wednesday, £264 to £264 2s. 6d.

Three Months: Thursday, £257 5s. to £257 10s.; Friday, £259 5s. to £259 10s.; Monday, £263 5s. to £263 10s.; Tuesday, £264 to £264 5s.; Wednesday, £261 12s. 6d. to £261 15s.

Spelter.—In regard to ordinary spelter, the metal has had dull and uninteresting markets under a slow trade demand and an ample supply available. The Continental demand has fallen off, but first-hand offers were not pressed on the market. In any case prices are relatively low, and could hardly go much worse.

The following are the week's prices:—

Ordinary: Thursday, £26 3s. 9d.; Friday, £26 10s.; Monday, £26 12s. 6d.; Tuesday, £26 12s. 6d.; Wednesday, £26 8s. 9d.

Lead.—The position in the market for soft foreign pig remains without improvement, with prices nearly £10 lower than those quoted a year ago, and demand still restricted by the uncertainty of the outlook. Business is consequently on an unimportant scale.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £20 17s. 6d.; Friday, £20 18s. 9d.; Monday, £21 1s. 3d.; Tuesday, £21 7s. 6d.; Wednesday, £21 6s. 3d.

Catalogues Received.

Welding Electrodes.—Messrs. Verdon Cutts & Company, Limited, of 87, Fargate, Sheffield, have utilised a four-page pamphlet to draw attention to their electrodes for welding purposes, which consist of three sections. Primarily there is the metallic core, which can be of two types, one for iron and the other for steel. This is surrounded by a flux, which in turn is covered by a sheath. The object of all this is to assure a smooth working arc.

Coke.—Under the caption of "The Choice of a Coke," the Priestman Collieries, Limited, of Milburn House, Newcastle-on-Tyne, have sent us an 18-page well-illustrated catalogue of the best type. One cannot forget its main message—that is, the firm has secured for its customers all that can be obtained by systematic chemical control and mechanical grading. We were specially interested in the illustration of a 24-ton turbo-air compressor made by Messrs. Smith, Patterson & Company, Limited, of Blaydon-on-Tyne, for the manufacture of which 3-in. coke cobbles were used. It is indeed a magnificent example of modern foundry practice, and praise can legitimately be given to any factor contributory to its successful production. We congratulate Messrs. Priestman on an excellent piece of publicity, which is infinitely superior to their last effort, which, if we remember correctly, we mistook for a banquet menu.

Moulding Machines.—Messrs. John Macdonald & Son, Limited, of Watt Street, Maryhill, Glasgow, N.W., have sent us a four-page leaflet describing and illustrating three types of moulding machines. Primarily there is the plain jar ramming machine, and it has been thought wise to illustrate one designed for core room use, though its application really extends to normal moulding practice. At the other end of this range is illustrated a machine with a lifting capacity up to seven tons—the No. 20 machine.

The next type is the jar and pattern-drawing machines. This is covered by the well-known Ajax series, which have achieved much popularity amongst iron, steel, non-ferrous and aluminium foundries for all kinds of light castings.

The third type is the jar ram, turnover and pattern-drawing machine, a type much favoured for repetition work. The fourth page of the leaflet gives in handy form the technical data, and here we suggest a slight compression of the tables with a view to the incorporation of a few figures, such as total weight and floor space occupied.

Publication Received.

Wall Chart.—The Staveley Coal and Iron Company, Limited, of Chesterfield, have sent us a copy of a wall chart carrying a picture of a tree, each branch of which is labelled with a product or a by-product of a modern metallurgical works. It should be very useful for schools and universities, as it will impress upon both master and student the ground to be covered in the training of men to fill responsible positions in modern ironworks.

Mr. M. Dickinson, who was engaged upon research into the nature and uses of moulding sand for the British Cast Iron Research Association, has joined the staff of Morris Motors, Limited.

"Pyrolyte" is a Fine Powder in a Water- & Air-tight Drum

"PYROLYTE" WILL KEEP FOR EVER IF THE LID IS RE-PLACED

"PYROLYTE" IS A REALLY PERFECT PATCHING

A graphic illustration of the wonderful strength of a joint made cold from

"PYROLYTE"

The unique Cold Setting, Heat Resisting Fire Cement.

Sample cwt. drum - **30/-** nett, carriage paid.

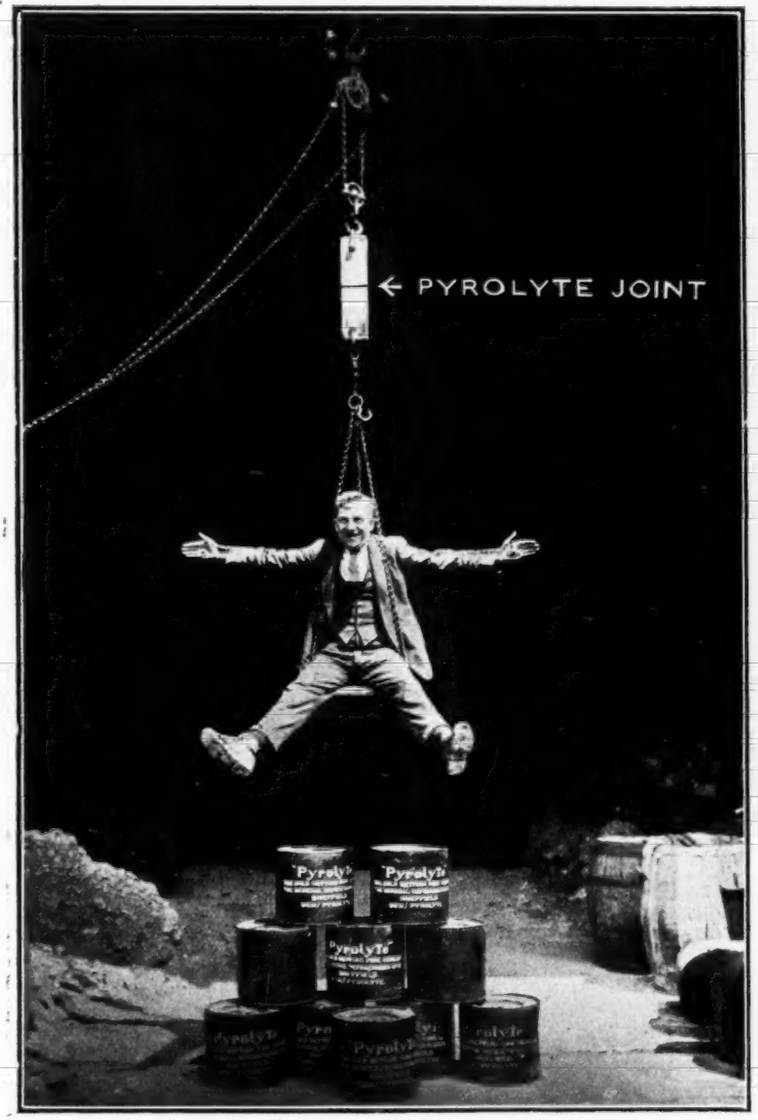
For all Furnaces Kilns & Ovens

Our photograph is a convincing demonstration of the "green" strength of "Pyrolyte" joints.

The picture shows two firebricks cemented end to end with "Pyrolyte" and allowed to set cold.

The joint is here seen supporting a 10-stone man, but it would have supported three others without breaking!

We have the identical bricks in our office, and will show you the test at our Kelham Island works!



For all Firebrick Constructions

"Pyrolyte" does not merely give "green" strength

Its great strength is not weakened by any commercial heat because the cement adheres to the brickwork with a grip which heat does not loosen.

The joint is, moreover, highly resistent to corrosion by slag or ash.

A firebrick wall set in "Pyrolyte" is truly MONOLITHIC and, if the exposed face is "washed," with a thin coating of the cement, the life is thereby prolonged to a remarkable extent

Telephone—22311 Sheffield. (3 lines)

Telegrams—"Refractory" Sheffield.

THE GENERAL REFRACTORIES Co. Ltd.

WICKER ARCHES, SHEFFIELD

LONDON: 92 Cannon Street, E.C. Tel.—City 8850.

GLASGOW: 58 York Street. Tel.—Central 1511.

"PYROLYTE" is merely an Infusible Portland Cement

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	58 13 9
Three months	54 18 9
Electrolytic	64 5 0
Tough	63 0 0
Best selected	63 10 0
Sheets	88 0 0
India	73 10 0
Wire bars	64 15 0
Do. December	64 13 9
Do. January	64 13 9
Ingot bars	63 13 9
H.C. Wire rods	69 5 0
Off. av. cash, Oct.	55 3 0⅞
Do. 3 mths., Oct.	55 5 3 3/16
Do., Sttlmnt., Oct.	55 2 11 15/16
Do., Electro, Oct.	62 8 9
Do., B.S., Oct.	61 18 9
Aver. spot price, copper, Oct.	55 2 11¼
Do., Wire bars, Oct.	62 12 4⅜
Solid drawn tubes	12½d.
Brazed tubes	12½d.
Wire	9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	9⅞d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£ s. d.
Standard cash	264 0 0
Three months	261 12 6
English	262 10 0
Bars	267 15 0
Straits	274 10 0
Australian	274 0 0
Eastern	268 5 0
Banca	276 10 0
Off. av. cash, Oct.	264 15 0⅝
Do., 3 mths., Oct.	261 16 4⅜
Do., Sttlmt., Oct.	264 14 9½
Aver. spot, Oct.	264 15 0¾

SPELTER.

Ordinary	26 8 9
Remelted	25 10 0
Hard	20 10 0
Electro 99.9	31 0 0
English	27 0 0
India	22 5 0
Zinc dust	35 0 0
Zinc ashes	9 0 0
Off. aver., Oct.	26 15 3 13/16
Aver., spot, Oct.	26 17 11¼

LEAD.

Soft foreign ppt.	21 6 3
English	22 10 0
Off. average, Oct.	20 14 3½
Average spot, Oct.	20 9 7

ZINC SHEETS, &c.

Zinc sheets, English	35 0 0
Do. V.M. ex whf.	33 0 0
Rods	42 0 0
Boiler plates	30 10 0
Battery plates	32 0 0

ANTIMONY.

Special brands, Eng.	64 10 0
Chinese	42 0 0
Crude	37 0 0

QUICKSILVER.

Quicksilver	23 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%..	8 17 6
45/50%	12 15 0 to 12 17 6
75%	20 0 0 to 22 0 0
Ferro-vanadium—	
35/40%	14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/- lb.
Ferro-titanium—	
23/25% carbonless	11½d
Ferro-phosphorus, 20/25%	£17 15 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/8 lb.
Ferro-chrome—	
2/4% car.	£33 0 0
4/6% car.	£23 0 0
6/8% car.	£22 17 6
8/10% car.	£22 5 0
Ferro-chrome—	
Max. 2% car.	£35 17 6
Max. 1% car	£41 12 6
Max. 0.70% car	£52 9 0
70% carbonless	1/4 lb.
Nickel—99%, cubes or pellets	£175 0 0
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105 0 0
Metallic chromium—	
96/98%	2/11 lb.
Ferro-manganese (net)—	
76/80%, loose	£13 0 0
76/80%, packed	£14 0 0
76/80%, export	£12 0 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 6
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/-lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.		£ s. d.
South Wales—			
Hvy. steel	2 17 6	to	3 0 0
Bundled steel and shrngs.	2 12 6	to	2 13 6
Mixed iron and steel	2 12 6	to	2 13 6
Heavy cast iron	2 17 6	to	2 18 6
Good machinery for foundries	3 2 6		
Cleveland—			
Heavy steel	2 17 6		
Steel turnings	2 6 0		
Cast iron borings	2 2 6		
Heavy forge	3 12 6		
Bushelled scrap	3 2 6		
Cast-iron scrap	3 2 6	to	3 5 6
Lancashire—			
Cast-iron scrap	3 5 0		
Hvy. wrought	3 2 6		
Steel turnings	2 2 6		

London—Merchants' buying prices delivered yard.

Copper (clean)	50 0 0
Brass (clean)	39 0 0
Lead (less usual draft)	18 10 0
Tea lead	16 0 0
Zinc	16 10 0
New aluminium cuttings	82 0 0
Braziery copper	46 0 0
Gunmetal	48 0
Hollow pewter	170 0 0
Shaped black pewter	130 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	72/-
Hematite M/Nos.	71/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	85/-
,, d/d Birm.	91/-
Midlands—	
Staffs. common*	—
,, No. 4 forge	62/6
,, No. 3 fdry.	65/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—

* d/d Birmingham.

Northants forge	55/-
,, fdry. No. 3	60/- to 61/-
Derbyshire forge	60/-
,, fdry. No. 3	65/- to 66/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	72/-
Hem. M/Nos.	76/-
Sheffield (d/d district)—	
Derby forge	66/-
,, fdry. No. 3	68/-
Lincs. forge	66/-
,, fdry. No. 3	68/-
E.C. hematite	85/-
W.C. hematite	90/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	74/-
Northants foundry No. 3	—
Dalzell, No. 3	100/- to 105/-
Summerlee, No. 3	89/- to 95/-
Glengarnock, No. 3	89/- to 95/-
Gartsherrie, No. 3	89/- to 95/-
Monkland, No. 3	89/- to 95/-
Coltness, No. 3	89/- to 95/-
Shotts, No. 3	89/- to 95/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

Iron—	£ s. d.		£ s. d.
Bars (cr.) nom.	9 15 0	to	10 15 0
Angles			—
Tees to 3 united ins.			—
Nut and bolt iron			9 0 0
Hoops			12 10 0
Marked bars (Staffs.) f.o.t.			13 0 0
Gas strip			12 0 0
Bolts and nuts, ¾ in. × 4 in.			15 5 0
Steel—			
Ship plates	8 2 6	to	8 7 6
Boiler plts.			10 10 0
Chequer plts.			10 5 0
Angles			7 12 6
Tees			8 12 6
Joists			7 12 6
Rounds and squares, 3 in. to 5½ in.			7 15 0
Rounds under 3 in. to ¾ in. (Untested)			8 0 0 and upwards
Flats, over 5 in. wide and up			9 2 6
Flats, 5 in. to 1½ in.			8 2 6
Rails, heavy	8 2 6	to	8 7 6
Fishplates			12 10 0
Hoops (Staffs.)			10 10 0
Black sheets, 24g.			10 7 6
Galv. cor. shts., 24g.			13 12 6
Galv. fencing wire 8g. plain			12 10 0
Billets, soft	£5 15 0	to	6 10 0
Billets, hard			8 2 6
Sheet bars	£5 12 6	to	5 15 0
Tin bars	£5 12 6	to	5 15 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2¼
Sheet to 10 w.g.	1 2¼
Wire	1 3¼
Rods	1 2¼
Tubes	1 8
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	19.76
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	16.00
Basic	20.00
Bessemer	19.76
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80% d/d	90.00
Bess rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.07
Steel bars	1.75
Tank plates	1.75
Beams, etc.	1.75
Skelp, grooved steel	1.75
Skelp, sheared steel	1.75
Steel hoops	2.30
Sheets, black, No. 24	2.80
Sheets, galv., No. 24	3.70
Sheets, blue an'l'd., 9 and 10	2.10
Wire nails	2.50
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	14/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box	17/9
,,	28×20	,,	35/6
,,	20×10	,,	—
,,	18¾×14	,,	—
C.W.	20×14	,,	16/10½
,,	28×20	,,	—
,,	20×10	,,	—
,,	18¾×14	,,	—
Terneplates	28×20	—	per box basis f.o.b.

SWEDISH IRON.

Bars, hammered, £18 10 0 to 19 0 0	
Rolled Ord.	£15 0 0 to £15 10 0
Nail rods	£15 7 6 to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£5 15 0 to £6 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	45%
Water	63¾%	40%
Steam	60%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Nov. 17	59	11	3	inc.	5/-
,, 18	59	16	3	,,	5/-
,, 21	59	13	9	dec.	2/6
,, 22	59	12	6	,,	1/3
,, 23	58	13	9	,,	18/9

Electrolytic Copper.

	£	s.	d.		
Nov. 17	64	0	0	inc.	5/-
,, 18	64	0	0	No change	
,, 21	64	10	0	inc.	10/-
,, 22	64	10	0	No change	
,, 23	64	5	0	dec.	5/-

Standard Tin (cash).

	£	s.	d.		
Nov. 17	262	12	6	No change	
,, 18	264	0	0	inc.	27/6
,, 21	267	0	0	,,	60/-
,, 22	267	0	0	No change	
,, 23	264	0	0	dec.	60/-

Tin (English ingots).

	£	s.	d.		
Nov. 17	260	15	0	No change	
,, 18	262	0	0	inc.	25/-
,, 21	265	5	0	,,	65/-
,, 22	265	15	0	,,	10/-
,, 23	262	10	0	dec.	65/-

Zinc Sheets (English).

	£	s.	d.		
Nov. 17	35	0	0	No change	
,, 18	35	0	0	,,	,,
,, 21	35	0	0	,,	,,
,, 22	35	0	0	,,	,,
,, 23	35	0	0	,,	,,

Spelter (ordinary).

	£	s.	d.		
Nov. 17	26	3	9	inc.	3/9
,, 18	26	10	0	,,	6/3
,, 21	26	12	6	,,	2/6
,, 22	26	12	6	No change	
,, 23	26	8	9	dec.	3/9

Lead (English).

	£	s.	d.		
Nov. 17	22	5	0	inc.	5/-
,, 18	22	5	0	No change	
,, 21	22	5	0	,,	,,
,, 22	22	10	0	inc.	5/-
,, 23	22	10	0	No change	

Exports of Iron Castings in October and the ten months 1927, compared with October and the ten months 1926.

	October, 1926.	October, 1927.	Ten months, 1926.	Ten months, 1927.	October, 1926.	October, 1927.	Ten months, 1926.	Ten months, 1927.
BUILDERS' CASTINGS—								
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers:—	Tons.	Tons.	Tons.	Tons.	£	£	£	£
To Argentine Republic	197	98	1,285	1,309	6,028	3,623	51,107	49,386
,, British South Africa	372	360	3,633	2,412	12,435	12,313	123,190	87,332
,, ,, East Indies	140	193	1,489	1,436	6,936	8,749	65,725	68,031
,, Australia	37	59	693	773	2,609	3,811	39,455	44,813
,, New Zealand	286	101	2,047	1,657	14,184	6,205	100,024	84,724
,, Other countries	917	724	6,956	6,428	46,628	36,528	338,111	321,643
Total	1,949	1,535	16,103	14,015	88,820	71,229	717,612	655,929
PIPES AND FITTINGS—CAST—								
To Argentine Republic	443	894	7,071	7,838	5,693	9,947	86,406	86,679
,, British South Africa	612	2,943	6,385	11,536	8,922	28,186	89,186	130,184
,, ,, India	465	743	6,926	5,804	6,188	10,802	89,684	89,661
,, Straits Settlements and Malay States	315	823	13,826	12,409	3,417	8,656	119,619	121,727
,, Ceylon	168	60	1,729	1,185	2,376	747	20,188	13,876
,, Australia	285	843	3,377	7,714	6,563	11,541	49,017	92,845
,, Other countries	3,610	5,715	39,287	51,842	60,719	70,579	559,142	673,784
Total	5,898	12,021	78,601	98,328	93,878	140,458	1,013,242	1,208,756
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	599	428	5,581	3,908	21,794	15,457	195,955	152,945
,, Enamelled	76	54	816	579	8,825	6,139	88,015	60,070
CASTINGS, in the rough—								
Iron	49	86	1,157	995	2,508	3,516	33,708	36,258
Steel	25	127	574	856	1,434	6,029	18,170	39,816

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON. E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
ROYAL BLDS., FISHER ST., SWANSEA.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
20, SECOND LINE BEACH, MADRAS.
1, HONG KONG ROAD, SHANGHAI.

REGISTERED TRADE MARK
LUMPER

OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5, SHAFFRAZ ROAD, RANGOON
NADIR HOUSE, MACLEOD ROAD, KARACHI.
1 SHAREH SONK EL TEWFIKIEH, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD MIDDLESBROUGH

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

AN experienced Foundry Manager, who is credited with the successful making of some of the most difficult castings for steam engines and textile machinery, desires re-employment in a similar capacity; unimpeachable references available.—Apply, Box 514, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN MOULDER desires to meet a firm prepared to take up the production of a new type of moulding machine.—Box 516, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN, energetic, desires position; thoroughly conversant in up-to-date Foundry practice; expert in machine moulding; eight years late position; full control of foundry and pattern shop; highest references.—Box 518, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PRACTICAL AND TECHNICAL FOUNDRYMAN requires position, Manager or Foreman; skilled in Moulding Machines, Plates, Green, Dry, Loam and Oil Sands, any Metals or Alloys; quadrupled output last place, four years.—Box 494, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Chilled Roll Caster, experienced in making Calender Rolls, etc., up to five tons in weight; regular employment for a good man.—Reply, giving particulars of experience and salary required, to Box 504, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, an experienced Moulder, to take charge of the manufacturing of Chilled Calender Rolls up to five tons in weight; regular employment for a good man.—Reply, giving experience and salary required, Box 506, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

AGENCIES.

ENGINEERING MERCHANT FIRM, having well-appointed Offices in Westminster, with qualified Secretarial and Technical Staff and Overseas Shipping connection, is prepared to act as London and/or Export Agents for a manufacturing firm.—Write, "T. J.," c/o J. W. VICKERS & COMPANY, LIMITED, 24, Austin Friars, E.C.2.

AGENTS ON COMMISSION, OR DISTRIBUTORS, wanted, all parts, calling on Foundries, for the Sale of "Metallic Phosphoro."—Write CHAS. HALL, 746, Seventh Street, Buffalo, N.Y., U.S.A.

BUSINESS FOR SALE.

THE PRINCIPALS of a well-known Foundry Equipment and Requisite Company are desirous of relinquishing their interests, and offer advantageous terms; the Company is a private limited one; payment can be spread over a period; reason for above, Principals retiring from Foundry business; the business offers splendid scope.—Firms interested should write, in confidence, Box 496, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY.

11 ACRES WORKS SITE—SHEFFIELD. 145,000 sq. ft. of SHOPPING, compact and convenient. Siding connections with L.M. & S. and L. & N.E. Rlys. Well-built and commodious Offices. Will sell whole or in lots to suit customers, or let on favourable terms. Unique opportunity for manufacturers.

Apply,

THOS. W. WARD, LTD.
ALBION WORKS, SHEFFIELD.

SALE BY TENDER.

By Order of the Directors of GIRLINGS, LIMITED, of MALDON, Essex.

Messrs.

FULLER, HORSEY & CO., are instructed to offer for Sale by Tender the BUSINESS and ASSETS of this Company in three Lots, as under:—

Lot One, the
FREEHOLD IRON and METAL FOUNDRY at EAST MALDON, Essex, opposite the Railway Station,

Lot Two, the Fixed and Loose
FOUNDRY PLANT and MACHINERY,

Lot Three, the
GOODWILL of the BUSINESS
with the
PATTERNS, DRAWINGS and FOUNDRY BOXES.

The Premises may be viewed by Orders, and Particulars with Forms of Tender, which are deliverable at the Auctioneers' Offices by 4 o'clock on

MONDAY, DECEMBER 5th, 1927,

may be had of MESSRS. FULLER, HORSEY, SONS & CASSELL, 11, Billiter Square, London, E.C.

MACHINERY.

MACHINERY PLANT, &c., FOR SALE.

HORIZONTAL COMPOUND DROP VALVE ENGINE, 12½-in. and 20-in. cyls., 26-in. stroke, by Robey.

250-kw. GENERATING SET, expansion engine, by Belliss & Morcom, Generator 460/550 volts.

320-h.p. "HORNSBY" OIL ENGINE, consisting of two side by side Engines, with Generator 500/600 volts.

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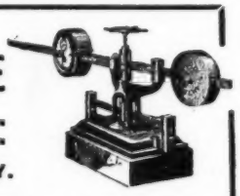

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